SERVICE MANUAL
OSCILLOSCOPE
MODEL COS5020-ST

Kikusui
INTERNATIONAL CORP.

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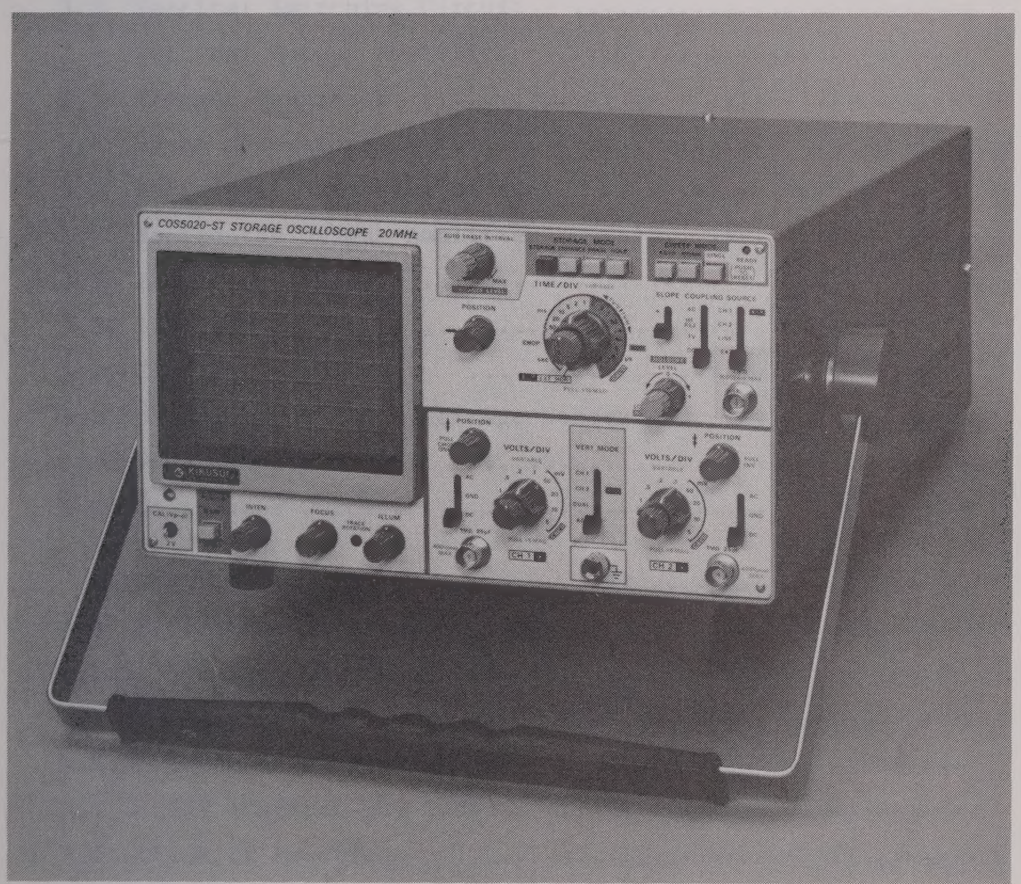
OSCILLOSCOPE

MODEL COS5020-ST



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1. GENERAL

1.1 Description

Kikusui Model COS5020-ST is a dual-trace oscilloscope with a 6-inch-rectangular-screen bistable storage CRT, with total frequency bandwidth of DC - 20 MHz, with the maximum sensitivity 1 mV/DIV, and with the maximum writing speed 20 μsec/DIV (50 DIV/msec) when its enhanced mode is employed.

It is incorporated with the various convenient features and excellent functions, an ideal instrument for a wide range of research and development works on electronic devices and equipments, various industrial tests and inspections, and physical and chemical studies.

1.2 Features

(1) BHD-type bistable storage CRT:

The BHD-type bistable storage CRT has a phosphor screen which provides a function as a storage target screen, making itself more resistant against burning. The CRT employs BHD (black matrix hybrid mesh dot screen), improving the contrast.

(2) AUTO ERASE mode:

The AUTO ERASE mode provides the automatic "record → hold → erase" actions for the measured signal for each sweep cycle. With this feature, operation can be conveniently done without manually pressing the ERASE button. The hold time is adjustable for a range of approximately 1 - 30 seconds with the ERASE INTERVAL control.

(3) ENHANCE mode:

The normal writing speed of the oscilloscope is 40 μsec/DIV (25 DIV/msec). When the oscilloscope is set to the ENHANCE mode, the writing speed can be increased to 20 μsec/DIV (50 DIV/msec) or higher with the ENHANCE LEVEL control.

(4) REMOTE ERASE terminal:

A terminal for remote erase control with an external signal (TTL CMOS logic signal) is provided on the rear panel, facilitating the oscilloscope with the capability to be used in a production line.

(5) High intensity circuit:

The acceleration voltage is high (3.15 kV) so that a sufficiently high trace intensity is attained even at the highest sweep speed. The reading electron acceleration voltage also is high (300 V) and thus the stored waveforms also can be displayed with a sufficiently high trace intensity.

(6) High stability with less drift:

The oscilloscope employs a newly-developed temperature compensation circuit, thereby greatly reducing drift of base lines and DC balance disturdance caused by temperature change.

(7) A trigger level lock function which makes triggering adjustment procedure unnecessary:

A newly-developed trigger level lock circuit is incorporated. This circuit eliminates the requirement for the troublesome triggering adjustment procedure not only for display of regular signals but also for that of video signals and large duty cycle ratio signals.

(8) Linear focus circuit:

A linear focus circuit is incorporated so that the best focus is maintained irrespective of intensity change.

(9) Excellent operability:

Lever switches and pushbutton switches of light torque type are used. These switches and other controls are laid out in the most rational locations by considering their purposes and the frequencies used, thereby attaining an excellent operability.

2. SPECIFICATIONS

CRT Circuit

Item	Specification	Remarks
Type	6-inch rectangular, direct-viewing bistable storage tube	
Phosphor	P31	Green
Effective screen size	8 × 10 DIV	1 DIV = 9.5 mm (0.37 in.)
Acceleration voltage	Approx. 3.15 kV	
Writing speed	40 µsec/DIV (25 DIV/msec) During ENHANCE mode operation, can be increased to up to 20 µsec/DIV (50 DIV/msec) or higher	
Read time	Approx. 60 minutes	
Erase time	Approx. 0.5 sec	
Storage section Operation mode	NORM: Normal oscilloscope operation STORAGE: Storage oscilloscope operation ENHANCE: Operation with enhanced writing speed. Adjustable with ENHANCE LEVEL control. ERASE: To erase the written waveform. During the SINGLE SWEEP mode operation, the RESET operation is done after the ERASE operation and the oscilloscope is reset to the READY state. HOLD: The waveform on the screen is instantaneously held and stored. The store state is released if changed to the NORM mode.	

Item	Specification	Remarks
AUTO ERASE	"Write → hold → erase" actions are done for each sweep cycle. The hold time is adjustable with the ERASE INTERVAL control for 1 - 30 seconds.	

Vertical axes

Item	Specification	Remarks
Sensitivity	NORM: 5 mV - 5 V/DIV ×5 MAG: 1 mV - 1 V/DIV	1-2-5 sequence, 10 ranges
Sensitivity accuracy	NORM: ±3% or better ×5 MAG: ±5% or better	10 to 35°C (50 to 95°F), 1 kHz, at 4 or 5 DIV
Vernier vertical sensitivity	To 1/2.5 or less of panel-indicated value	
Frequency bandwidth	NORM: DC - 20 MHz, within -3 dB ×5 MAG: DC - 15 MHz, within -3 dB AC coupling: Low limit frequency 10 Hz	At 50 kHz, 8 DIV
Rise time	NORM: Approx. 17.5 nsec 5 MAG: Approx. 23 nsec	
Input impedance	1 MΩ ±2%, 25 pF ±2 pF	
Square wave characteristics	Overshoot: Not greater than 5% Other distortions: Not greater than 3% (At 10 mV/DIV range)	Other ranges: 3% added to the values shown in the left column. 10 to 35°C (50 to 95°F)
DC balance shift	NORM: ±0.5 DIV ×5 MAG: ±2.0 DIV	
Display modes	CH1: CH1 single channel	When CH1 POSITION knob is pulled out (CHOP ONLY position), the two traces are displayed in the CHOP mode over the entire ranges.
	CH2: CH2 single channel	
	DUAL: CHOP: 0.5 sec - 1 msec/DIV ALT: 0.5 msec - 0.2 μsec/DIV	
	ADD: CH1 + CH2	

Item	Specification	Remarks
Chopping repetition frequency	Approx. 250 kHz	
Input coupling	AC/GND/DC	
Maximum allowable input voltage	400 V (DC + AC peak)	AC: 1 kHz or lower
Common mode rejection ratio	50:1 or better at 50 kHz, sinusoidal wave	Applicable only when sensitivities of CH1 and CH2 are equal.
Isolation between channels	1000:1 or better at 50 kHz 30:1 or better at 40 MHz	At 5 mV/DIV range
CH1 signal output	Approx. 100 mV/DIV when open; approx. 50 mV/DIV when 50-ohm termination	
CH2 INV BAL	Balanced point variation, at the center of screen: 1 DIV or less	PULL CH2 POSITION

Triggering

Item	Specification	Remarks
Triggering source	CH1, CH2, LINE, and EXT (CH1 and CH2 can be selected only when the vertical mode is DUAL or ADD. In other cases, triggering source is automatically selected by the VERT MODE switch.)	
Coupling	AC, HF REJ, TV, DC	
Polarity	+ or -	
Sensitivity	DC - 10 MHz: 0.5 DIV (0.10 V) DC - 40 MHz: 1.5 DIV (0.20 V) Video signal: 2.0 DIV (0.25 V) AC coupling: Attenuates signal components of lower than 10 Hz HF REJ: Attenuates signal components of higher than 50 kHz	The values enclosed in the parentheses are the input sensitivities during the EXT triggering mode opration.

Item	Specification	Remarks
Triggering modes	AUTO: Sweeps run in the free mode when no triggering input signal is applied.	Satisfies the sensitivity specification for signal repetition frequency of 50 Hz or higher.
	NORM: When no triggering signal is applied, the trace is in the READY state and not displayed.	
	SINGLE: One-shot sweep with triggering signal. Can be reset to the READY state by means of RESET switch. The READY lamp (LED) turns on during the READY state or in the sweep operation.	
LEVEL LOCK	Satisfies the value of the above trigger sensitivity plus 0.5 DIV (0.05 V) for signal of duty cycle 20:80 and repetition frequency 50 Hz - 20 MHz.	
EXT triggering signal input	EXT HOR input terminal is used in common.	
Input impedance	1 MΩ ±2%, approx. 30 pF	
Maximum allowable input voltage	100 V (DC + AC peak)	AC frequency not higher than 1 kHz

Horizontal axis (Time base)

Item	Specification	Remarks
Sweep time	NORM: 0.5 µsec - 1 sec/DIV ×10 MAG: 50 nsec - 0.1 sec/DIV	1-2-5 sequence, 20 ranges
Sweep time accuracy	NORM: ±3%	10 to 35°C (50 to 95°F)
Vernier sweep time control	To 1/2.5 or slower of the panel-indicated value	
Holdoff time	Continuously variable to 2 times or higher of sweep length (time) at 0.5 µsec/DIV - 1 msec/DIV ranges	

Item	Specification	Remarks
Sweep magnification	10 times (maximum sweep time 50 nsec/DIV)	
Magnified sweep time accuracy	1 µsec/DIV - 1 sec/DIV ranges: ±5% 0.5 µsec/DIV ranges: ±8%	10 to 35°C (50 to 95°F)
Linearity	NORM: ±3% ×10 MAG: ±5% (8% at 0.5 µsec/DIV)	
Position shift caused by sweep magnification	Within 1 DIV at CRT screen center	
X-Y mode	X-axis: CH1 input signal Y-axis: CH2 input signal	Triggering signal coupling in DC mode.
Sensitivity	Same as CH1 vertical axis	
Sensitivity accuracy	NORM: ±4% ×5 MAG: ±6%	10 to 35°C (50 to 95°F), at 1 kHz, 4 or 5 DIV
Frequency bandwidth	DC - 500 kHz (-3 dB)	
X-Y phase difference	Not greater than 3° at DC - 50 kHz	
EXT HOR mode	Trace swept by an external horizontal signal applied to the EXT TRIG IN terminal. Vertical axis modes are CH1, CH2, DUAL and ADD modes in the CHOP mode.	
Sensitivity	Approx. 0.1 V/DIV	
Frequency bandwidth	DC - 500 kHz (-3 dB)	
Phase difference between vertical axis	Within 3° (at DC - 50 kHz)	

Z axis

Item	Specification	Remarks
Sensitivity	3 Vp-p (Trace becomes brighter with negative input.)	
Frequency bandwidth	DC - 5 MHz	
Input resistance	Approx. 5 kΩ	
Allowable input voltage	50 V (DC + AC peak)	AC frequency not higher than 1 kHz

Calibration voltage

Item	Specification	Remarks
Waveform	Positive-going square wave	
Frequency	1 kHz ±20%	
Duty ratio	Within 45:55	
Output voltage	2 Vp-p, ±2%	
Output resistance	Approx. 2 kΩ	

Remote erase terminal

ON-OFF control with TTL and CMOS signal. The ERASE action is triggered by the rising edge of the signal; it is inhibited by the LOW (ON) level of the signal.

Line power requirements

Voltage: 100 V, 115 V, 215 V, 230 V; with ±10% allowance.
Selectable by connector change.

Frequency: 50 Hz or 60 Hz

Power consumption: Approx. 65 VA

Operating environment

To satisfy specifications: 5 to 35°C (41 to 95°F), 85% RH

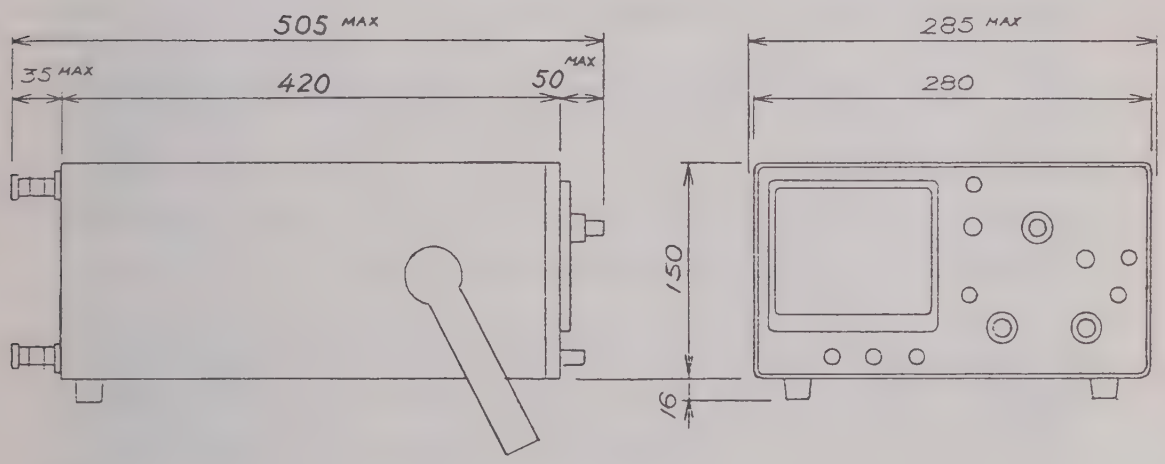
Maximum operating ranges: 0 to 40°C (32 to 104°F), 90% RH

Mechanical specifications

Mainframe dimensions: 280 W × 150 H × 420 D mm
(11.02 W × 5.91 H × 16.54 D in.)

Maximum dimensions: 285 W × 200 H × 505 D mm
(11.22 W × 7.87 H × 19.88 D in.)

Weight: Approx. 7.8 kg (17.2 lbs)



Accessories

P060-S probes (10:1, 1:1; 1.5 m) ..	(89-03-0300)	2
942A terminal adaptors	(W4-986-011)	2
Power cord		1
Instruction manual		1

3. CIRCUIT DESCRIPTION

3.1 General

The overall circuit structure of the oscilloscope is as depicted with a block diagram in Figure 3-6. It is comprised of a horizontal and a vertical deflection circuit for moving the beam spot in the X- or Y-axis direction on the CRT screen, a CRT circuit which displays and retains waveforms on the CRT screen, a calibrator circuit for calibrating the instrument probe, and a power supply circuit for supplying powers to the various circuits of the instrument.

The vertical amplifier circuit has two mutually independent preamplifiers (CH1 and CH2), a vertical switching circuit, a delay line, and a vertical output amplifier.

Each of the preamplifiers amplifies or attenuates its input signal of several millivolts to several hundreds volts into a level suitable for handling by the subsequent stage. The conditioned vertical signals are sent to the vertical switching circuit. The trigger signals also are picked off at this stage.

The vertical switching circuit electronically switches the vertical signals received from the CH1 and CH2 preamplifiers. The switched signal is fed to the vertical output amplifier. The trigger signals also are switched and fed as internal trigger signals to the trigger generator.

The vertical output amplifier amplifies the vertical signal, which is received through the delay line circuit, into a level of several volts to several tens volts for vertically deflecting the beam spot on the CRT screen.

The horizontal deflection circuit has a trigger generator, a sweep generator, a horizontal switching circuit, and a horizontal output amplifier.

The trigger generator receives the internal trigger signal from the vertical switching circuit or an external trigger signal from the EXT TRIG INPUT terminal and generates a trigger pulse signal.

The sweep generator is driven by the trigger pulse signal of the trigger generator and produces a sawtooth signal. The sweep generator produces a sawtooth signal even when no trigger pulse is applied to it (the AUTO mode).

The horizontal switching circuit electronically switches the sawtooth signals received from the sweep generator and the CH1 HOR signal received from the vertical switching circuit when in the X-Y mode of operation, and sends the resultant signal to the horizontal output amplifier.

The horizontal output amplifier amplifies the output signal of the horizontal switching circuit to a level of several volts to several tens volts in order to drive horizontally the beam spot on the CRT screen.

The CRT circuit is comprised of a high voltage generator (the HV regulator) to accelerate the electron beam emitted from the CRT cathode, a Z-axis amplifier to amplify the signal to adjust the trace intensity or to blank out the return traces, a CRT control circuit to operate the CRT tube in its optimal state, and a storage circuit to store waveforms on the CRT screen.

The HV regulator provides a high voltage (3000 volts) which is applied to the CRT cathode to accelerate the electrons emitted by it.

The Z-axis amplifier amplifies the unblanking signals received from the sweep generators and the trace intensity control signal to a level of several tens volts in order to be applied to the 1st grid (control grid) of the CRT via the CRT circuit.

The CRT circuit provides the various voltages for the CRT electrodes so that the CRT operates in an optimal state and displays sharply-focussed less-distorted signal waveforms. It also conditions the signal received from the Z-axis amplifier into a level suitable for application to the CRT.

The storage circuit retains waveforms on the CRT screen by changing the potential of the electrically conductive layer which is formed on the CRT phosphor layer, or erases overall CRT screen.

3.2 Preamplifiers

The CH1 preamplifier amplifies the signal of the CH1 or X input terminal. The CH2 preamplifier amplifies the signal of the CH3 or Y input terminal. A detailed block diagram is shown in Figure 3.1.

- Input coupling switch:

The input coupling switch (S102/S202) selects the input coupling mode for AC, GND, or DC. When the GND state is selected, the preamplifier input is isolated from the input terminal and is grounded so that the base line (0 level) on the CRT screen can be verified.

- Attenuators:

Each of the CH1 and CH2 attenuator circuits consists of two attenuators: The 1st attenuator for 1/1, 1/10 and 1/100, and the 2nd attenuator for 1/1, 1/2, 1/4 and 1/10. By switching these attenuators with the VOLTS/DIV switch (S101/S201), the signal can be attenuated for a total range of 1/1 to 1/1000 in 10 steps.

The 1st attenuator directly attenuates the signal received from the input coupling switch and feeds the attenuated signal to the voltage follower. The 2nd attenuator attenuates the low-impedance output signal of the voltage follower and feeds the attenuated signal to the 1st differential cascade amplifier.

- Impedance converter:

The impedance converter provides with its source follower (Q101 Q201) a high input impedance to prevent the loading effect on the high-impedance attenuator circuit and provides a low output impedance with its emitter follower (Q103, Q104, Q203, Q204) to drive the 2nd attenuator.

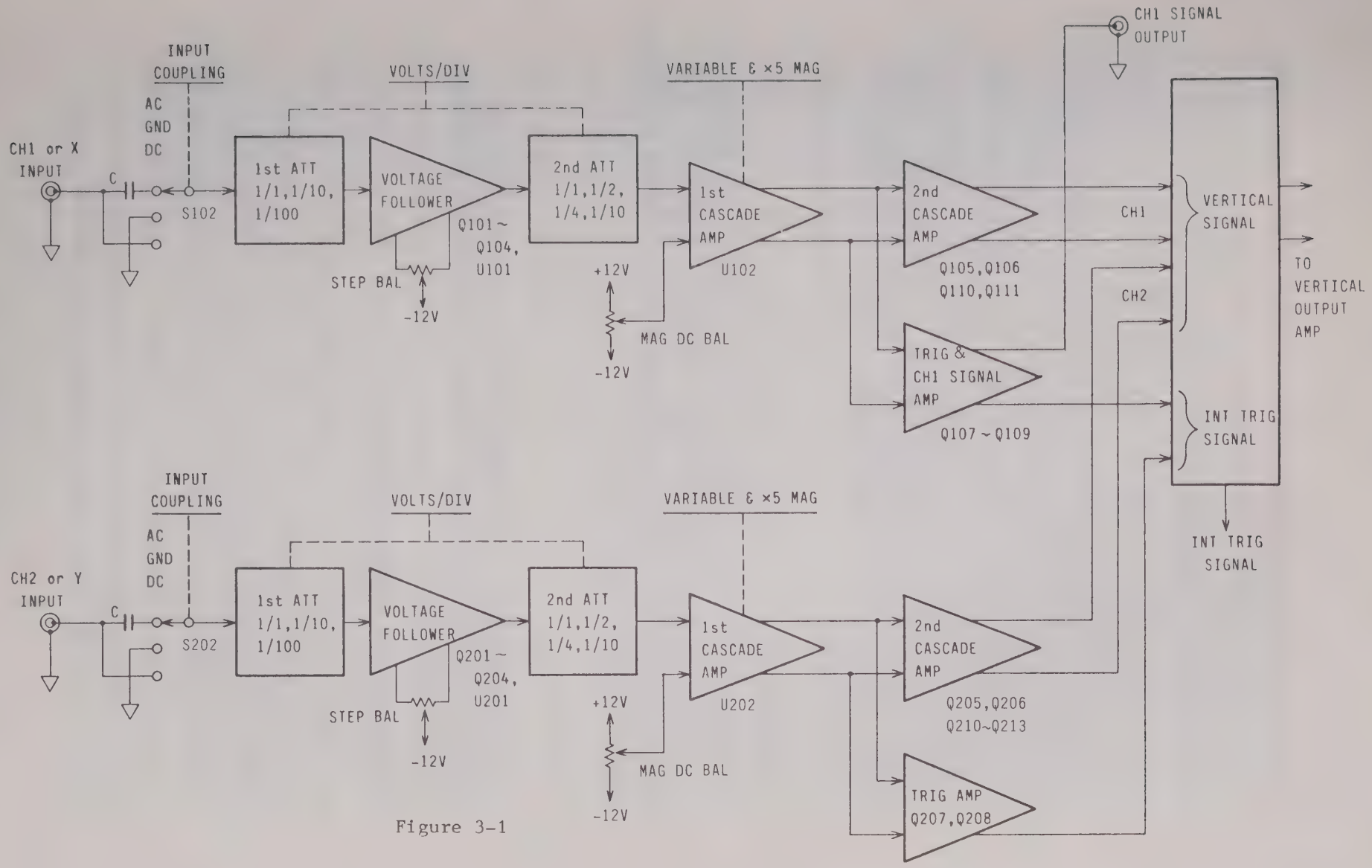

CH1 SIGNAL OUTPUT
INPUT COUPLING
AC
GND
DC
VOLTS/DIV
VARIABLE & ×5 MAG
CH1 or X INPUT
C
S102
1st ATT 1/1,1/10, 1/100
VOLTAGE FOLLOWER
Q101~Q104, U101
STEP BAL
-12V
2nd ATT 1/1,1/2, 1/4,1/10
+12V
MAG DC BAL
-12V
1st CASCADE AMP
U102
2nd CASCADE AMP
Q105,Q106 Q110,Q111
TRIG & CH1 SIGNAL AMP
Q107~Q109
CH1
CH2
VERTICAL SIGNAL
TO VERTICAL OUTPUT AMP
INT TRIG SIGNAL
INT TRIG SIGNAL
INPUT COUPLING
AC
GND
DC
VOLTS/DIV
VARIABLE & ×5 MAG
CH2 or Y INPUT
C
S202
1st ATT 1/1,1/10, 1/100
VOLTAGE FOLLOWER
Q201~Q204, U201
STEP BAL
-12V
2nd ATT 1/1,1/2, 1/4,1/10
+12V
MAG DC BAL
-12V
1st CASCADE AMP
U202
2nd CASCADE AMP
Q205,Q206 Q210~Q213
TRIG AMP
Q207,Q208

Figure 3-1

The high impedance operational amplifier (U101, U201) compensates for DC offset (STEP BAL) and DC drift.

- 1st differential cascade amplifier:

The 1st differential cascade amplifier is comprised of an emitter-connected differential current amplifier (U102-1/2, U202-1/2) and a current-to-voltage converter (U102-2/2, U202-2/2) which converts the differential collector output current of the differential current amplifier into a voltage signal. This amplifier also has the VARIABLE circuit for continuously-variable adjustment of sensitivity between two adjoining vertical deflection sensitivity ranges selected by the VOLTS/DIV switch and the ×5 MAG switch for magnifying the vertical sensitivity by 5 times to realize the 1 mV/DIV sensitivity.

- VARIABLE circuit:

The VARIABLE circuit attenuates to 1/2.5 or less the gain by shunting, with a potentiometer (RV104/RV204) and resistors (R146, R147 for CH1; R246, R247 for CH2), part of the currents (mutually reverse in polarity) amplified by U102-1/2, U202-1/2.

- ×5 MAG circuit:

The ×5 MAG function is to increase the vertical sensitivity by 5 times by switching the emitter resistor of the 1st differential cascade amplifier.

- 2nd differential cascade amplifier:

The 2nd differential cascade amplifier (Q105, Q106, Q110, Q111/Q205, Q206, Q210 - Q213) amplifies the output of the 1st differential cascade amplifier to a sufficient level for driving the vertical switching circuit. The grounded-base stage (Q110, Q111/Q210 - Q213) of this cascade amplifier has a function of preventing the switching signal of the vertical switching circuit from being returned to the preceding stage and mixed into the trigger signal or the signal of the CH1 signal output amplifier. For the CH2 signal,

this amplifier also has a function of inverting the polarity. The polarity inverting function is accomplished by switching with the INV switch the base grounding stages of Q210/213 and Q211/212 to which the collector currents which have been current-amplified by Q205 and Q206 are fed in a crossing manner.

Different from the case of the 1st differential cascade amplifier, the output signal of the 2nd differential cascade amplifier is fed directly in the from of the current signal to the diode gate of the vertical switching circuit. The current signal for vertical positioning of the trace on the CRT screen is added to the output current signal of the 2nd differential cascade amplifier, being controlled by potentiometer RV111/RV211 of the positioning circuit.

c Trigger signal amplifier:

This circuit amplifies with its Q107, Q108/Q270, Q208 the signal picked off from the 2nd differential amplifier, and converts with its Q109 the collector output of Q107 into a low-impedance CH1 output signal which is fed to J-6C. The collector output signal of Q108/Q208 is fed as a trigger signal to the internal trigger signal switching circuit.

3.3 Vertical Switching Circuit

The vertical switching circuit is comprised of a vertical signal switching circuit (diode gate circuit) which electronically switches the vertical signals received from the CH1 and CH2 preamplifiers, an internal trigger signal switching circuit which electronically switches the trigger signals, and a switching logic circuit which controls these switching circuits.

The vertical signal switching circuit is, as shown in Figure 3-2, comprised of a diode gate circuit, an ADD BAL circuit, and a switching buffer circuit which receives the signal from the diode gate circuit.

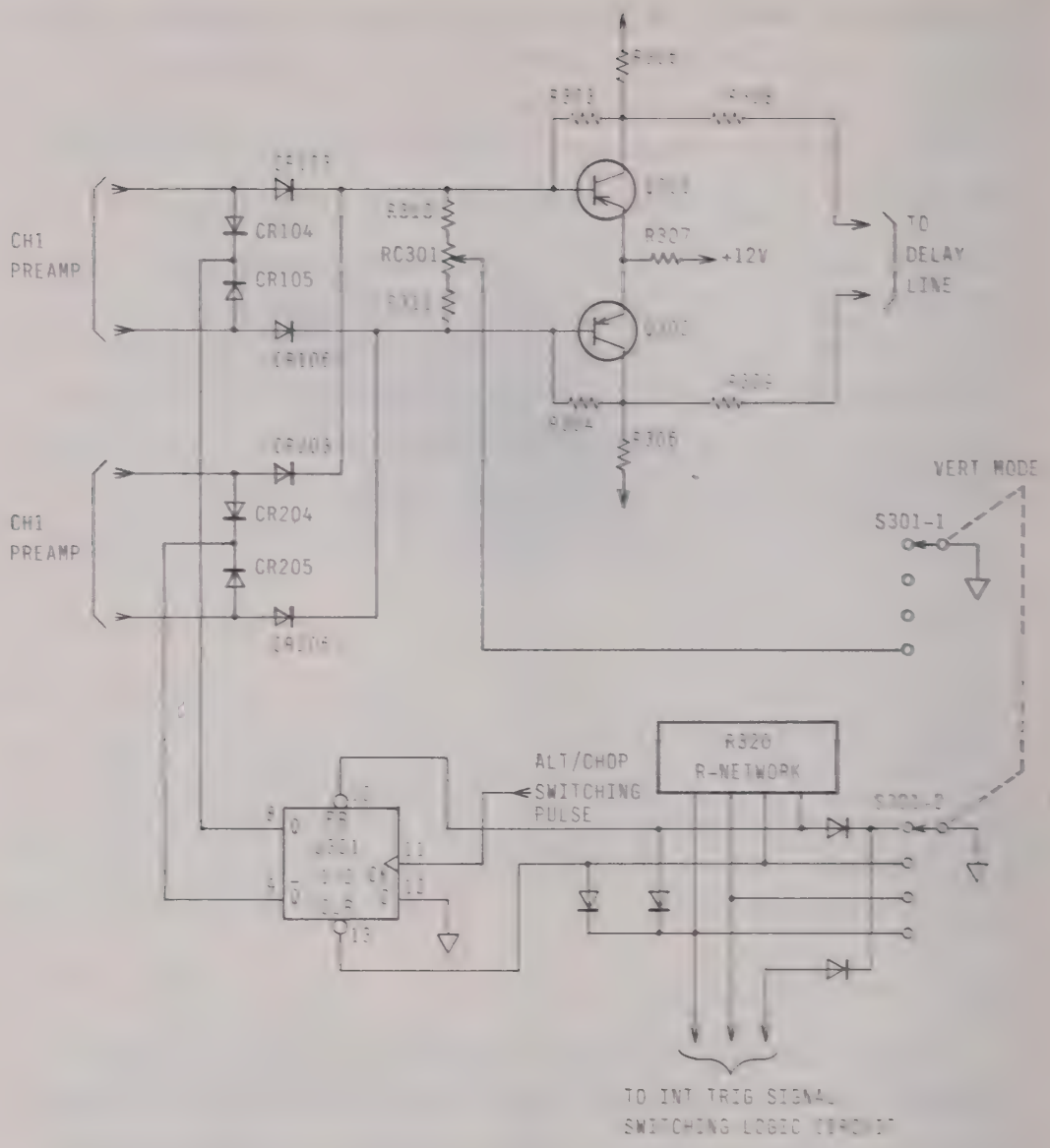


Figure 3-2. Vertical signal switching circuit

o Diode gate circuit:

The diode gate circuit (CR103 - CR106/CR203 - CR206) selects or adds the CH1 and CH2 signals being controlled by the signal of the switching logic circuit according to the mode selected by the VERT MODE switch (S301).

For example, when the VERT MODE switch is set to CH1, the CH1 control signal becomes the Hi state, and the CH2 and CH3 control signals become Lo state. Consequently the output signal of the CH1 preamplifier is fed through CR103 and CR106 to the switching buffer circuit consisting of Q301 and Q302. The signals of the other channels are fed through respective diodes (CR204/205) to the control circuit. Thus, the signal of CH1 alone is fed to the switching buffer circuit and the signals of the remaining channels are blocked.

o ADD BAL circuit:

When the ADD mode is selected by the VERT MODE switch, the control signals of both CH1 and CH2 become the Hi state, the signals of the CH1 and CH2 preamplifiers are fed through CR103, CR106/CR203, CR206 to the switching buffer circuit, and the sum of the two signals is fed to the output circuit. The function of the ADD BAL circuit is to compensate for the DC balance shift caused by the above addition operation, with its ADD BAL control (potentiometer RV301).

o Internal trigger signal switching circuit:

The internal trigger signal switching circuit directly controls, with the control signal fed from the switching logic circuit, the diode gate circuit (CR107, CR108, CR207, CR208) which is similar to the vertical signal switching circuit. The trigger signal which has passed the diode gate circuit is delivered as the internal trigger signal via connector P-7.

o Switching logic circuit:

The switching logic circuit is comprised of a vertical switching logic circuit which controls the vertical signal switching circuit and an internal trigger switching logic circuit which controls the internal trigger signal switching circuit.

The vertical signal switching logic circuit is comprised of a flip-flop (U301-2/2) which has a preset/clear terminal. Switching of channels can be done by turning on or off the preset/reset terminal of the flip-flop.

The internal trigger switching logic circuit controls the internal trigger signal switching circuit by switching it for the mode selected by the VERT MODE switch and TRIG SOURCE switch, as shown in the following table.

VERT MODE	CH1	CH2
CH1	Triggered by CH1	
CH2	Triggered by CH2	
DUAL	Triggered by CH1	Triggered by CH2
ADD	Triggered by CH1	Triggered by CH2

o Switching buffer amplifier:

The vertical signal which has passed the diode gate is fed to the switching buffer amplifier (Q301, Q302). The vertical signal amplified by the switching buffer amplifier is fed to the vertical output amplifier via the P-9/J-9 connector and 2-conductor shielded cable.

3.4 Vertical Output Amplifier

The vertical amplifier is comprised of a drive amplifier and a final amplifier. The drive amplifier amplifies the signal received from the switching buffer amplifier and drives the final amplifier. The final amplifier amplifies the signal to a level sufficient for driving the vertical deflection plates of the CRT.

- Final amplifier:

The final amplifier boosts the signal to a level sufficient for driving the vertical deflection plates of the CRT. It is comprised of a pair of feedback-type SEPP amplifiers.

Transistors Q307, Q308/Q309, Q310 current-amplify the signal to a level sufficient for driving transistors Q312, Q313/Q314, Q315. The signal which has been voltage-amplified by transistors Q312, Q313/Q314, Q315 is returned to the input circuit through the negative feedback circuit (R346/R347). The gain in this case is as follows:

$$AV \fallingdotseq \frac{R346}{R388} \qquad Av' \fallingdotseq \frac{R347}{R339}$$

Transistors Q311/Q316 are for the dynamic bias circuit which controls the bias current with respect to the repetition frequency of the signal in order to economize power consumption.

3.5 Trigger Generator

The trigger generator is comprised of a trigger pulse generator circuit which produces a trigger pulse signal for driving the sweep generator and an AUTO circuit which produces a free-run signal for automatic sweep operation when the trigger signal is not synchronized or no trigger signal is applied.

The trigger pulse generator circuit of the trigger generator is comprised of a source switch which selects a trigger signal source, a coupling switch which selects a coupling mode in conformity with the nature of the trigger signal source, an impedance converter circuit which converts the high-impedance trigger source signal

into a low-impedance signal with which to drive the level comparator circuit which controls the start point (triggered point) of the signal waveform displayed on the CRT screen, a TV synchronization separator circuit which picks off the synchronization signal from the TV video signal, and Schmitt trigger circuits which convert the output signals of the level comparator circuit and TV synchronization signal separator circuit into TTL level signals.

- Source switch:

The source switch (S401) selects the internal trigger signal fed from Q401, the line trigger signal fed from R622, or the external trigger signal fed from P-12. The selected signal is fed to the coupling switch.

- Coupling switch:

The coupling switch (S402-1) selects the coupling mode: It selects the DC mode for direct coupling of the signal fed from S401, the AC mode for discarding the DC component, or the HF REJ mode for coupling via a low-pass filter of 50 kHz, -3 dB. Switch S402-2 selects ON or OFF of the TV synchronization signal separator circuit which facilitates observation of TV video signals.

- Impedance converter:

The impedance converter is a source follower (Q403) with FET. It converts the trigger signal selected by the source switch and coupling switch into a low-impedance signal, which is fed to drive the level comparator circuit (Q404, Q405).

- AUTO circuit:

The AUTO circuit is comprised of a uni-junction transistor (UJT) circuitry made up by connecting mutually the bases and collectors of a PNP transistor (Q416) and an NPN transistor (Q415). This circuit converts the high-speed pulse output signal of the Schmitt circuit into a DC signal (the AUTO signal) with which to drive the sweep generator.

3.6 Sweep Generators

The sweep generator produces a sawtooth signal for the oscilloscope. The sweep generator consists of the sweep gate circuit which receives the trigger signal from the trigger generator and produces the sweep gate signal for starting sweeps, the sweep start comparator which maintains stably the sweep start point, the sawtooth sweep generator which produces a sawtooth wave in conformity with the time constant selected by the TIME/DIV switch, the sweep length circuit which controls the length of sweeps, the hold off circuit which controls the sweep return period and pause period, and the sweep gate enable circuit which controls the sweep gate circuit in conformity with the AUTO, NORM or SINGLE mode as selected by the MODE switch for the signals of the above control circuits.

- Sweep gate:

The sweep gate circuit employs a flip-flop TTL IC (U402-1/2) with preset/clear function. The trigger pulse of the trigger generator is applied to the CLOCK (Pin No. 1) terminal, the enable signal of the sweep gate enable circuit to the CLEAR (Pin No. 15) terminal, and the enable signal and AUTO signal of the AUTO circuit to the PRESET (Pin No. 4) terminal through the NOR gate circuit. The Q (Pin No. 5) terminal output is applied as the unblanking signal to the Z-axis amplifier and the Q (Pin No. 5) terminal output is fed to the sweep start comparator circuit and becomes the sweep gate signal. Even when no trigger pulse signal is applied to the CLOCK (Pin No. 1) terminal, the Q output can be made the low state with the AUTO signal of the PRESET (Pin No. 4) terminal so that the sweep gate signal is generated and the circuit operates in the free-run mode.

- Sweep start comparator:

The sweep start comparator (Q419, 420) is a differential amplifier which lets the sweep gate signal pass, maintaining constant the sweep start level.

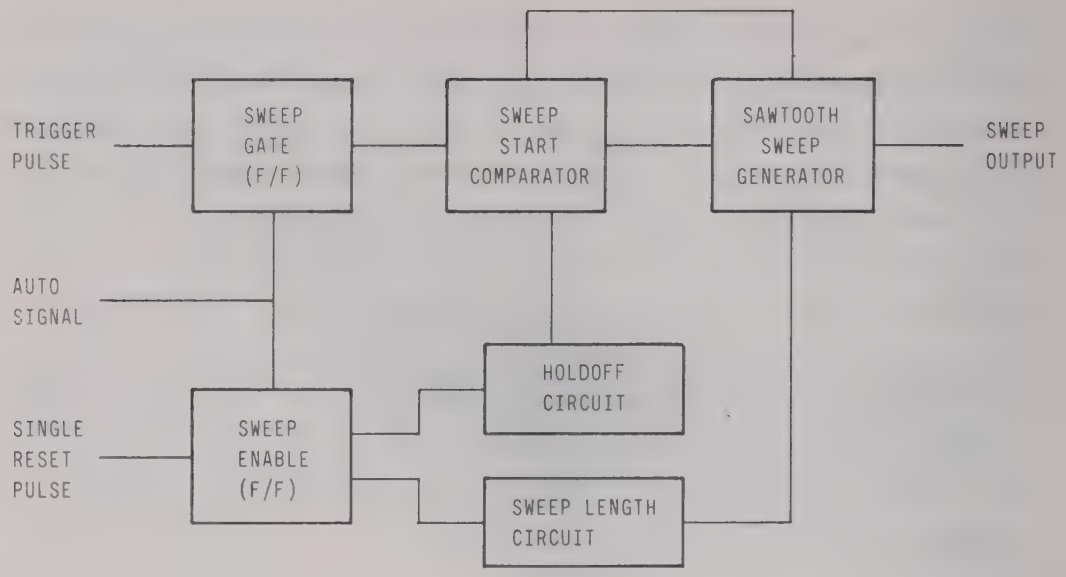


Figure 3-3. Sweep generator

- Sawtooth generator:

The sawtooth generator is comprised of a gate transistor amplifier, a Miller integrator, an integration time constant switching circuit, and a TIME/DIV switch which controls the switching circuit. The gate transistor amplifier (Q423) controls the Miller integrator circuit in such manner that the start level control signal and sweep gate signal of the sweep start comparator do not affect the integration time constant. The Miller integrator (Q425) produces a sawtooth signal with the time constant selected by the integration time constant selector circuit.

The integration time constant selector circuit is comprised of a resistance switching circuit and a capacitance switching circuit. A resistance array consisting of R491, R492 and R493 is switched by the TIME/DIV switch and capacitor C459/C460 is switched by Q426 in accordance with information fed from the TIME/DIV switch, thereby covering all of the sweep ranges.

o Sweep length circuit:

This circuit divides the sweep generator output signal by R461/R462 and shapes the signal waveform with Q418 to obtain a sweep length signal.

o Holdoff circuit:

The holdoff circuit generates a holdoff (pause) time signal proportional to the sweep time by producing a triangular wave with an integrator circuit and making use of the rise time of the triangular wave. The integrator, with its Q421, selects the time constant in accordance with the integration output voltage in order to cover a wide time range. The output signal of the integrator circuit is shaped by Q417 into a holdoff signal.

o Sweep gate enable circuit:

The sweep gate enable circuit employs the flip-flop IC (U402-2/2) which makes up a pair with the sweep gate circuit. The holdoff signal is applied to the PRESET (Pin No. 10) terminal, the length signal is applied to the CLEAR (Pin No. 14) terminal, and the enable signal is delivered from the Q (Pin No. 9) terminal. This enable signal presets or clears the sweep gate circuit.

When in the NORM sweep mode, the output signal of the AUTO circuit is blocked and, if no trigger signal is applied, the circuit is in the ready state. When in the SINGLE sweep mode, the holdoff circuit remains idle and a one-shot sweep is effected by the reset signal applied from the CLOCK (Pin No. 13) terminal.

3.7 Horizontal Switching Circuit

The horizontal switching circuit is comprised of a switching buffer circuit which prevents switching distortion from being sent to the sweep circuit of the preceding stage, and a display switching circuit which electronically switches the sweep signal and CH1 HOR (X) signal.

- Switching buffer circuit:

The switching buffer circuit is of a grounded-base amplifier (Q430).

- Display switching circuit:

The display switching circuit, with its analog signal multiplexer IC (U404), selects the sweep signal or the CH1 HOR (X) signal.

3.8 Horizontal Output Amplifier

The horizontal output amplifier consists of a drive amplifier which selects between NORM and ×10 MAG mode for the horizontal signal received from the horizontal switching circuit and drives the output amplifier, and an output amplifier which drives the horizontal deflection plates of the CRT.

- Drive amplifier:

The drive amplifier (Q501 - Q504) converts the horizontal signal received from the horizontal switching circuit into a differential signal with which to drive the output amplifier. With Q501 and 502, gain of the differential amplifier can be multiplied by a factor of 10 for the ×10 MAG function.

- Output amplifier:

The output amplifier (Q505 - Q512) is comprised of feedback-type SEEP amplifiers which are symmetrical for right and left and provide sufficient speed and output voltage for driving the horizontal deflection plates of the CRT. The signal current-amplified by Q505/Q506 is converted into a voltage signal by Q507 - Q512 to obtain a sufficiently high gain and a sufficiently low output impedance. By means of negative feedback resistor R518/R519 a stable gain and wide and flat frequency response are attained.

3.9 Z-axis Amplifier

The Z-axis amplifier is comprised of an input circuit and an output amplifier. The input circuit merges the unblanking signal of the sweep generator, the external intensity modulation signal applied through the Z-axis input terminal, and the overall intensity control signal. The output amplifier amplifies the merged signal into a sufficient level for driving the G1 grid of CRT.

- Input circuit:

The input circuit merges the unblanking signal of the sweep generator, the chopped blanking signal, the external intensity modulation signal applied via the Z-axis input terminal, and the overall intensity control signal. The resultant compound signal is fed to the output amplifier.

- Output amplifier:

The output amplifier amplifies the above compound signal to several tens volts. It is of a feedback-type SRPP circuit (Q654, Q656, Q658). This amplifier also generates (with its Q655, Q657, Q659) a linear focus signal which is in the inverted phase of the unblanking signal. The amplified unblanking output signal and linear focus signal are fed to the G1 and P1 of the cathode-ray tube through the CRT circuit to control the intensity and focus of the displayed waveform.

3.10 Storage Circuit

The storage circuit is comprised of a read electron gun section and an STB electrode control section which controls the storage background (STB) matrix electrode of the CRT screen.

The read electron gun section has a gun which emits read electrons and an electrode section which makes up an electronic lens to supply a uniform electron shower onto the CRT screen.

The electron shower poured onto the CRT screen is absorbed by the STB electrode, except the matrix dots which have been charged by electrons of the write electron gun. The charged matrix dots emit secondary electrons which impinge upon the phosphor screen to illuminate it thereby displaying waveforms.

The STB electrode control section provides a level voltage or pulse voltage signal for each of the operating modes of the oscilloscope, namely, for the regular oscilloscope mode, write mode, erase mode, and enhance mode.

The STB electrode control section is comprised of an auto erase control circuit (U802-2/2) which controls auto erase intervals, an erase pulse generator (U801-1/2, 2/2) which generates an erase pulse signal, an enhance pulse generator (U802-2/2) for enhanced writing speed, and an STB drive circuit (Q817, Q818) to drive the STB electrode.

- Auto erase control circuit:

The auto erase control circuit generates a pulse signal (Hi level) of approximately 0.5 to 30 seconds as the sweep length signal is applied from the collector of Q418 of the sweep circuit to the monostable multivibrator (U802-1/2) which is able to adjust the duration of the output pulse. The output pulse is applied to the erase pulse generator and Q811. During the period Q811 is on, the sweep circuit does not become ready for the next sweep because no holdoff end signal is applied. The sweep circuit becomes ready for the next sweep when the auto erase interval has elapsed and Q811 has become off.

- Erase pulse generator:

The erase pulse generator produces a pulse signal to erase overall CRT screen where waveforms are retained, being dictated by the pulse signal received from the auto erase control circuit or by the signal of the ERASE switch on the front panel.

The circuit operates as follows: The monostable multivibrator (U801-1/2) generates an erase enable pulse (Hi level) which is converted into an erase switch pulse (Lo level). The pulse is shaped into an erase pulse by the CR differential circuit (C821, R822). The erase pulse is converted into a current pulse signal by Q816 and then fed to the STB drive circuit.

o Enhance pulse generator:

The enhance pulse generator produces a pulse signal to enhance the writing speed by rasing tentatively the STB electrode potential at the instant the sweep is over.

The circuit operates as follows: The monostable multivibrator (U801-1/2) accepts the sweep length signal fed from the collector of Q418 of the sweep circuit and generates an enhance pulse signal. This signal is fed to Q815 whose collector current varies in response to emitter resistance change. The output signal of Q815 is fed to the STB drive circuit.

o STB drive circuit:

The STB drive circuit amplifies the erase pulse and the enhance pulse to a level sufficiently high to drive the STB electrode. The circuit is comprised of a totem pole type single-ended push-pull amplifier (Q817, Q818). The supply voltages of this circuit is sufficiently high (+145V and -150V) to amplify the erase pulse and the enhance pulse.

A timing chart of the storage circuit is shown in Figure 3-4. Settings of the front panel controls of the oscilloscope in this case is as follows:

Vertical axis	Single channel	CH1 (Apply CAL 2V input.)
Time base	Sweep time	1ms/DIV
	Sweep mode	AUTO
	Holdoff	NORM
Storage circuit	Storage	ON
	Enhance	OFF (ON only when in enhance mode)
	Hold	OFF

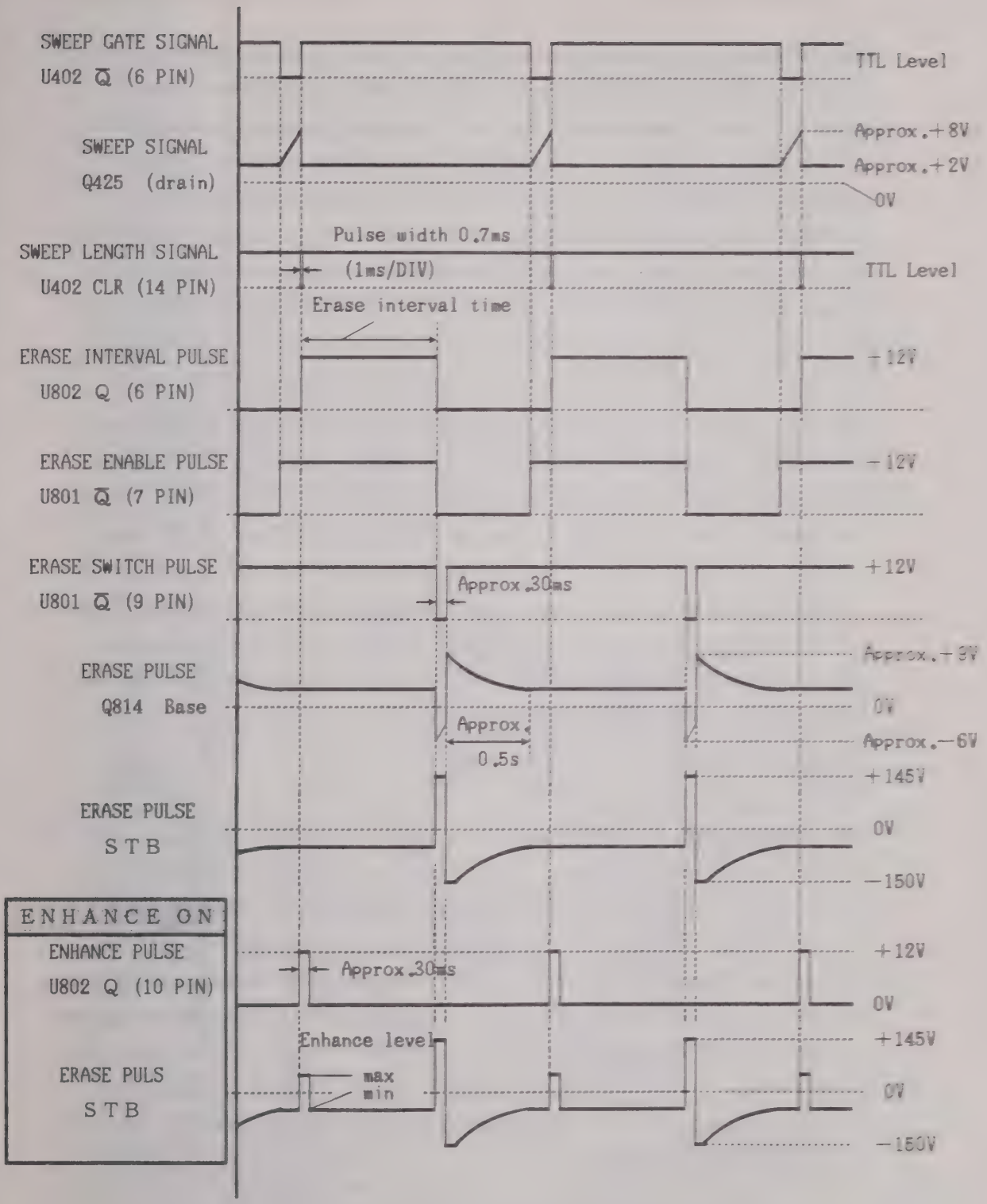


Figure 3-4. Timing chart of the storage circuit

3.11 CRT Control Circuit

The CRT control circuit is comprised of a DC regeneration circuit which converts the linear focus signal and the unblanking output signal of the Z-axis amplifier into the operating-voltage signal of the CRT in order to be applied to the focus electrode and G1 electrode of the CRT, semi-fixed potentiometers ASTIG (RV652), GEOMETRY and SUB-FOCUS (RV651), a trace rotation circuit for adjusting the trace direction in parallel with the horizontal graticule lines, and an illumination circuit for illuminating the graticule.

o DC regeneration circuit:

The DC regeneration circuit converts the linear focus signal and unblanking signal of several tens to several hundreds volts into AC signals with the switching signal of the DC-DC converter circuit, and then converts them back into DC signals with respect to the cathode voltage and focus reference voltage of the sub-focus potentiometer in order to provide a focus signal and an unblanking signal of the operating voltages of the CRT. (Thus, in effect, the DC regeneration circuit makes the low or medium voltages superimposed on the high voltage for CRT operation.)

3.12 HV Regulator (High Voltage Generator)

The high voltage generator produces an acceleration voltage (-3000 V) applied to the CRT cathode. The circuitry is a DC-DC converter with blocking oscillator (Q651), with resonance of the secondary coil winding. A high AC voltage of approximately 3000 Vp-p (frequency approximately 30 kHz) is generated by the blocking oscillator and it is rectified into a negative voltage of -3000 V. The voltage is fed back to the control circuit to obtain a stabilized acceleration voltage. Part of the AC voltage is fed through a capacitor-coupling circuit to the DC regeneration circuit in order to be used as the switching signal.

3.13 Power Supply Circuit

The power supply circuit steps up or down with its power transformer the AC line voltage into various voltages and rectifies them to DC supply voltages for the various circuits of the oscilloscope. The primary winding of the power transformer is of a split type, in order that the oscilloscope can be operated on various AC line voltages by connecting the transformer taps in series or parallel as required by means of the line voltage selector plug (P-47). The secondary windings are one winding (6.3 V) for the write electron gun heater, one winding (8 V) for the read electron gun (8 V), and three windings (16 V × 2, 140 V, 150 V) for the various circuits of the oscilloscope. The AC supply voltages of these windings are supplied directly or after being rectified and regulated to respective circuits of the oscilloscope. A schematic diagram of the power supply circuit is shown in Figure 3-5.

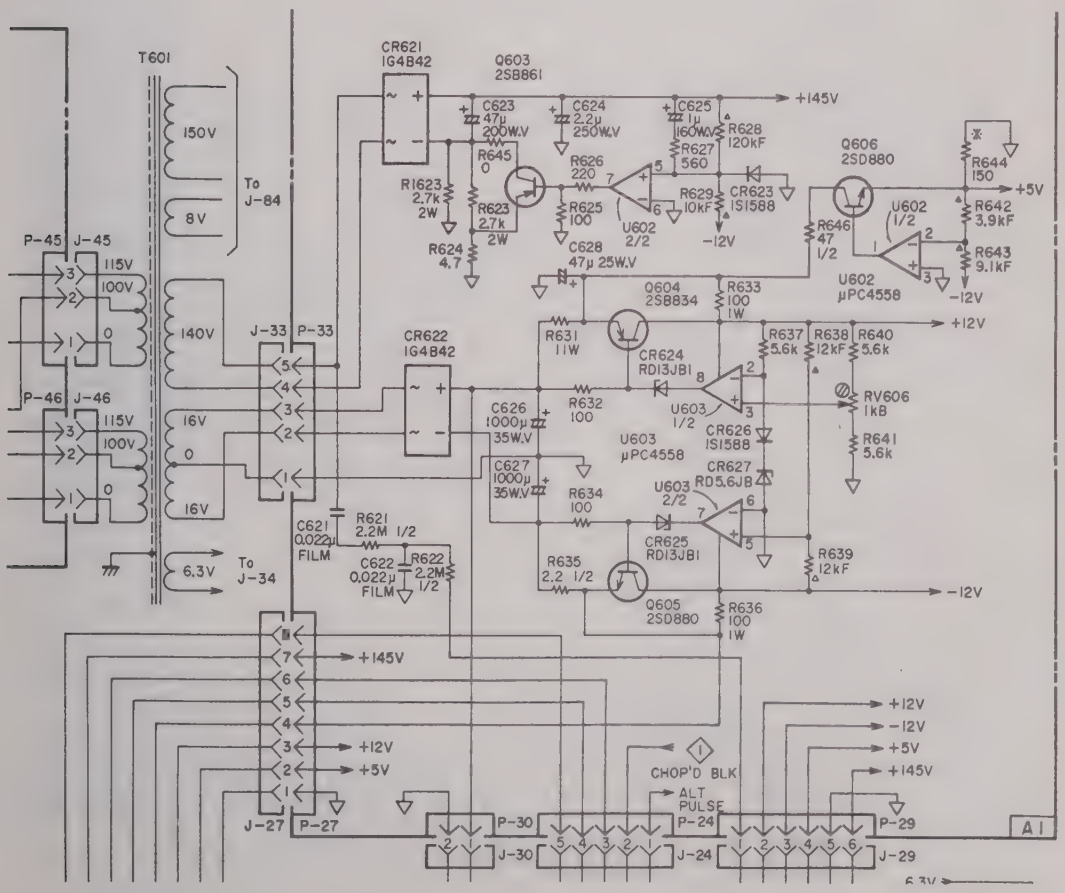


Figure 3-5

3.14 Calibrator Circuit

The calibrator circuit provides square-wave calibration voltage signal of 2 Vp-p which is used for calibration of the probe and the amplifiers when they are operated in the non-calibrated mode. The voltage accuracy of the calibration signals is 2% or better. The calibration signal is produced by generating a signal with the multivibrator of CMOS IC (U1601 1/4, 2/4), shaping the signal and dividing the voltage signal with resistors.

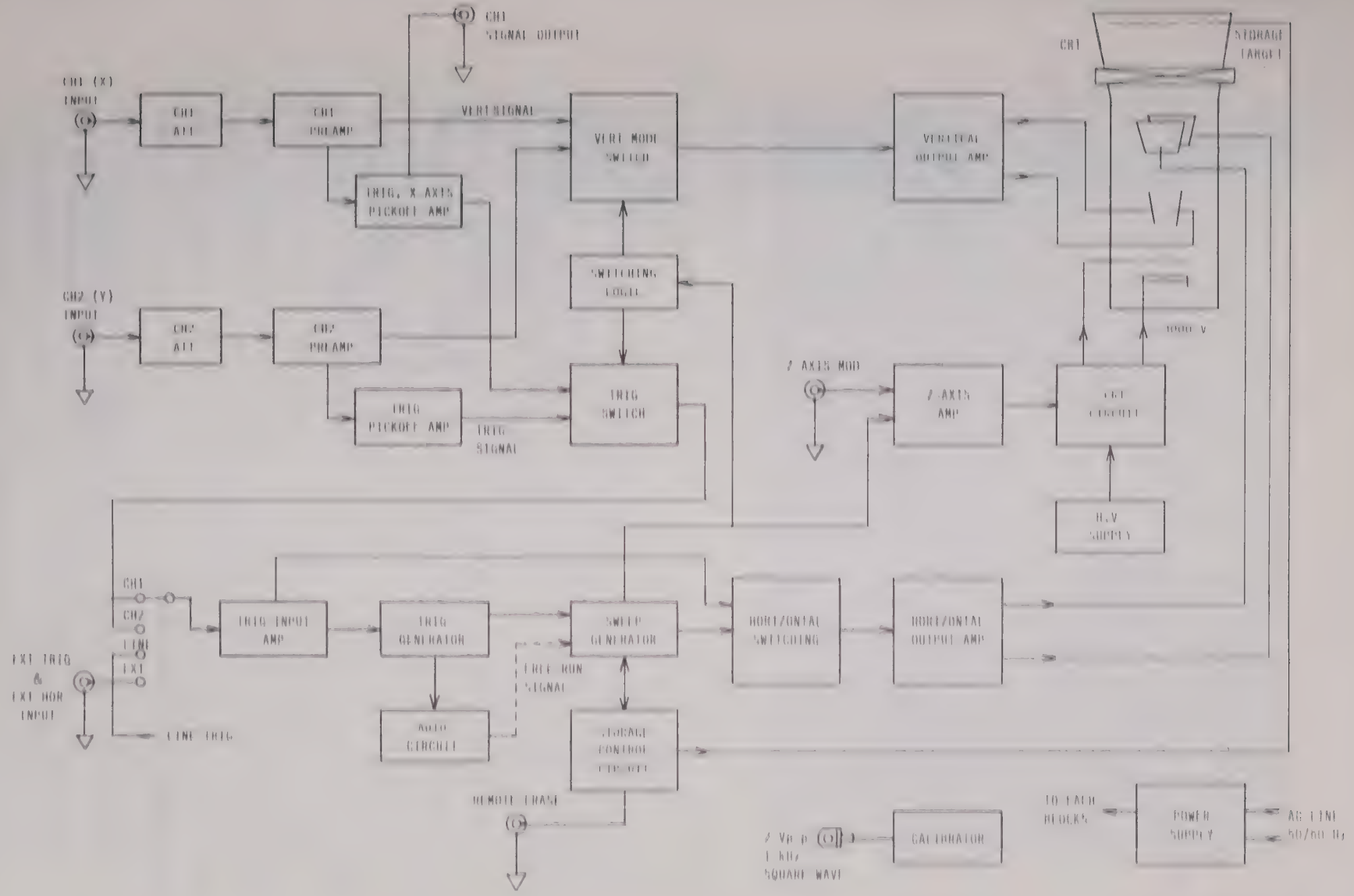


Figure 3-6

BLOCK DIAGRAM

4. MAINTENANCE

4.1 Preventive Maintenance

The major preventive maintenance items are cleaning and visual inspection of the instrument. It is highly recommendable to render preventive maintenance service periodically on an established time schedule.

4.1.1 Removing the Case

To remove the case, remove the five screws shown in Figure 4-1 and pull out the instrument chassis.

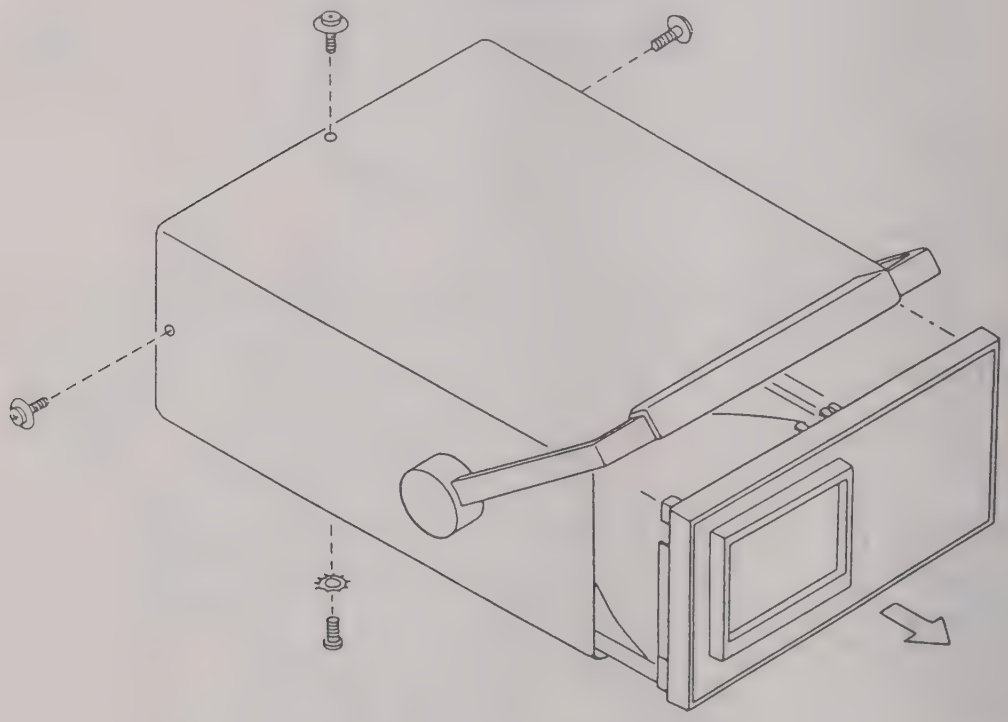


Figure 4-1

4.1.2 Cleaning the Instrument

Blow away dust collected in the instrument by using a clean compressed air. Clean especially carefully the insulators of the high voltage circuit in order to prevent insulation degradation. Also clean carefully the heat sinks to prevent heat radiation degradation.

Precautions: Do not wash the instrument with water or detergent. To remove adherent dirt from inside or outside of the instrument, use of chlorophlorocarbon (Freon) is recommended. Never use benzene, thinner, toluene or other volatile or highly active chemicals to clean either inside or outside of the instrument.

4.1.3 Check of Semiconductors

It is not recommendable to attempt to check directly the transistors and other semiconductors of the instrument for periodical maintenance service. It is most recommendable to find out whether such circuit elements are operating normally or not through proper manipulation of the instrument. If the instrument does not operate normally when it is manipulated properly, render appropriate service referring to the paragraphs of calibration or troubleshooting given in this manual.

4.1.4 CRT (Cathode-ray Tube)

The storage CRT of the COS5020-ST has a special conductive layer on the screen, different from the CRT of a regular oscilloscope. The performance of the layer varies by aging and consequently the requied recording voltage of the oscilloscope varies. Thus, although the recording voltage is adjusted at an appropriate value when the oscilloscope is shipped from the factory, recording may become dim or overall screen may become bright thereby making recording unsuccessful as the oscilloscope is used for a long time. When this has occurred, adjust the oscilloscope referring to (g) "Adjustment of the Storage Circuit" of Section 4.3.3 "Calibration Procedure". This adjustment may be needed at approximately 100 hours, 200 hours, 300 hours, 500 hours, and 1000 hours of oscilloscope operation (total hours of operation in the storage mode, excluding those in the other modes). To provide data on operation time in the storage mode, the oscilloscope is incorporated with a 1000-hour timer. The location of the timer is shown in Figure 4-2.

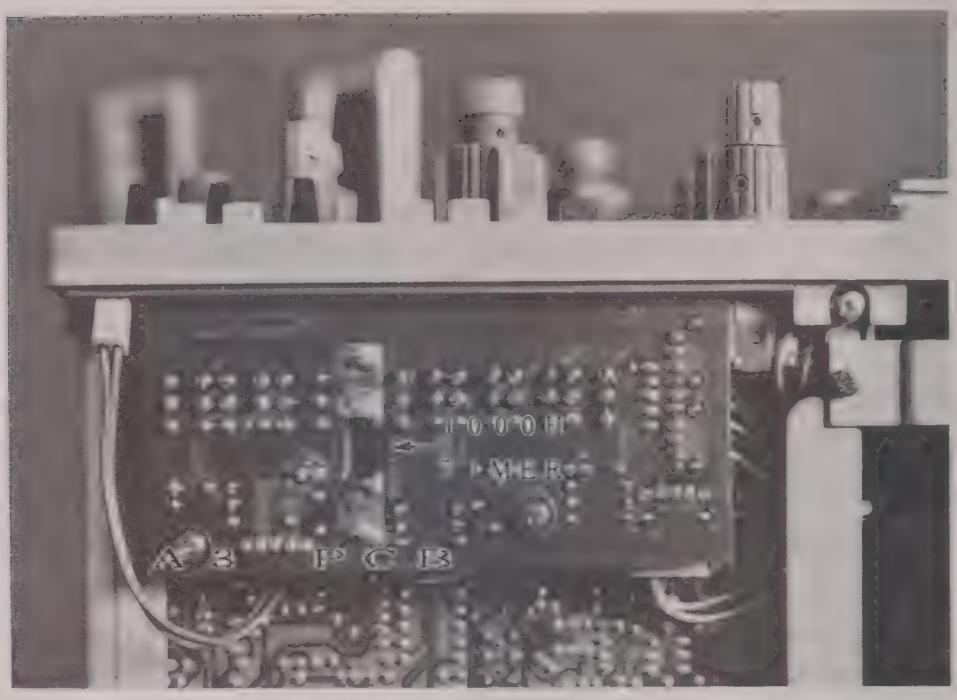


Figure 4-2

4.2 Check of Functions

Check the instrument operation as described in the subsequent sections for individual functions. When malfunction is found, calibrate or repair the instrument referring to the calibration or troubleshooting section.

The basic panel control setting for instrument function check is as given in Table 4-1.

Table 4-1

	Control	Setting
CRT Circuit	INTEN	Appropriate intensity (2 - 3 o'clock position)
	FOCUS	Mid-range
	ILLUM	Mid-range
Vertical Circuit	VOLTS/DIV	5mV/DIV (CH1, CH2)
	VARIABLE	CAL'D (CH1, CH2)
	PULL ×5 MAG	OFF (CH1, CH2)
	INPUT COUPLING	DC (CH1, CH2)
	POSITION	Mid-range (CH1, CH2)
	VERT MODE	CH1
	CH2 INV	OFF
Trigger Circuit	SOURCE	CH1
	COUPLING	AC
	SLOPE	+
	LEVEL	LOCK (full counterclockwise)
	SWEEP MODE	AUTO
Horizontal Circuit	TIME/DIV	1mS
	VARIABLE	CAL'D
	PULL ×10 MAG	OFF
	H POSITION	Mid-range
	HOLDOFF	Full counterclockwise
Storage Circuit	STORAGE	OFF
	ENHANCE	OFF
	HOLD	OFF
	AUTO ERASE	Full counterclockwise
	ENHANCE LEVEL	Full counterclockwise

4.2.1 Vertical Axis Operation Check

a) STEP Balance Check

(1) Set the panel controls as shown in Table 4-1.

(2) Set the CH1 input to the GND state. Changing the vertical sensitivity switch (VOLTS/DIV) from 5 mV/DIV to 10 mV/DIV and then back to 5 mV/DIV, check that vertical shift of the trace is within ±0.2 DIV.

(3) Set the VERT MODE switch to CH2.

(4) Set the CH2 input to the grounded state. Changing the vertical sensitivity switch (VOLTS/DIV) from 5 mV/DIV to 10 mV/DIV and then back to 5 mV/DIV, check that vertical shift of the trace is within ±0.2 DIV.

b) ×5 MAG Balance Check

(1) Set the panel controls as shown in Table 4-1.

(2) Set the CH1 input to the GND state. Changing the CH1 sensitivity alternately to the ×5 MAG state and the NORMAL (×1) state by pulling out and pushing in the VARIABLE control, check that vertical shift of the trace is within ±0.2 DIV.

(3) Set the VERT MODE switch to CH2.

(4) Set the CH2 input to the GND state. Changing the CH2 sensitivity alternately to the ×5 MAG state and the NORMAL (×1) state by pulling out and pushing in the VARIABLE control, check that vertical shift of the trace is within ±0.2 DIV.

c) DC Balance Check

(1) Set the panel controls as shown in Table 4-1.

(2) Set the CH1 input to the GND state. Turning the VARIABLE control to the full clockwise and counterclockwise positions, check that vertical shift of the trace is within ±0.2 DIV.

(3) Set the VERT MODE switch to CH2.

(4) Set the CH2 input to the GND state. Turning the VARIABLE control to the full clockwise and counterclockwise positions, check that vertical shift of the trace is within ±0.2 DIV.

d) ADD Balance Check

(1) Set the panel controls as shown in Table 4-1. Set the VERT MODE switch to DUAL.

(2) Accurately align (overlap) the CH1 and CH2 traces at the center of the screen.

(3) Set the VERT MODE selector to ADD and check that the resultant vertical shift of the trace is within ±0.2 DIV.

e) CH2 INV Balance Check

(1) Set the panel controls as shown in Table 4-1.

(2) Set the VERT MODE switch to CH2 and the INPUT COUPLING switch to GND.

(3) Move the trace to the center of the screen with the CH2 POSITION control. Turning on and off the CH2 INV function by pulling out and pushing in the CH2 VERT POSITION control, check that vertical shift of the trace is within ±1 DIV.

f) Vertical Positioning Check

(1) Set the panel controls as shown in Table 4-1.

(2) Set the CH1 input to the GND state. Check that the trace is movable to any vertical position on the screen by means of the CH1 VERT POSITION control.

(3) Set the VERT MODE switch to CH2.

(4) Set the CH2 input to the GND state. Check that the trace is movable to any vertical position on the screen by means of the CH2 VERT POSITION control.

g) Vertical Sensitivity Check (See Table 4-2)

(1) Set the panel controls as shown in Table 4-1.

(2) Apply to the CH1 input an amplitude calibration signal from a vertical axis calibrator for each of the ranges and check that the sensitivity accuracy is 3% or better.

(3) Pull out the CH1 VARIABLE control (set to ×5 MAG) and check that the sensitivity accuracy of each of the ranges is 5% or better.

(4) Set the VERT MODE switch to CH2.

(5) Apply to the CH2 input an amplitude calibration signal from a vertical axis calibrator for each of the ranges and check that the sensitivity accuracy is 3% or better.

(6) Pull out the CH2 VARIABLE control (set to ×5 MAG) and check that the sensitivity accuracy of each of the ranges is 5% or better.

Table 4-2

Vert Axes	MAG Setting	Sensitivity Setting (VOLTS/DIV)	Vertical Axis Calibrator Range Setting	Amplitude on Screen	Sensitivity Tolerance
CH1 & CH2	NORMAL	5 mV/DIV	20 mV	4 DIV	±0.12 DIV
		10 mV/DIV	50 mV	5 DIV	±0.15 DIV
		20 mV/DIV	0.1 V	5 DIV	±0.15 DIV
		50 mV/DIV	0.2 V	4 DIV	±0.12 DIV
		0.1 V/DIV	0.5 V	5 DIV	±0.15 DIV
		0.2 V/DIV	1 V	5 DIV	±0.15 DIV
		0.5 V/DIV	2 V	4 DIV	±0.12 DIV
		1 V/DIV	5 V	5 DIV	±0.15 DIV
		2 V/DIV	10 V	5 DIV	±0.15 DIV
		5 V/DIV	20 V	4 DIV	±0.12 DIV
	5 MAG	1 mV/DIV	5 mV	5 DIV	±0.25 DIV

h) VERT VARIABLE Function Check

(1) Set the front panel controls as shown in Figure 4-1.

(2) Apply to the CH1 input an amplitude calibration signal (square wave) of 4 DIV from a vertical axis calibrator.

(3) Turning counterclockwise the CH1 VARIABLE knob, check that the displayed pulse amplitude is reduced in response. Check that the amplitude is reduced to less than 1/2.5 of the original amplitude (reduced to less than 1.6 DIV) as you turn the VARIABLE control to the fully counterclockwise position.

(4) Set the VERT MODE switch to CH2.

(5) Apply to the CH2 input an amplitude calibration signal (square wave) of 4 DIV from a vertical axis calibrator.

(6) Turning counterclockwise the CH2 VARIABLE knob, check that the displayed pulse amplitude is reduced in response. Check that the amplitude is reduced to less than 1/2.5 of the original amplitude (reduced to less than 1.6 DIV) as you turn the VARIABLE control to the fully counterclockwise position.

i) ALT and CHOP Trace Check

(1) Set the front panel controls as shown in Table 4-1.

(2) Set the VERT MODE switch to the dual channel state. Set both CH1 and CH2 INPUT COUPLING switches to GND.

(3) Move the CH2 trace to a position apart from the CH1 trace by 2 - 3 DIV.

(4) Check that the two traces are displayed in the CHOP mode when in the 0.5 s/DIV to 1 ms/DIV ranges or in the ALT mode when in the 0.5 ms/DIV to 0.5 μs/DIV ranges, except when the time base range selector is set to X-Y or EXT HOR.

j) Vertical-axis Low-frequency Response Check

(1) Set the front panel controls as shown in Table 4-1.

(2) Set CH2 to 10 mV/DIV and apply to it a quality square wave signal of approximately 1 kHz with an amplitude for approximately 5 DIV from a vertical axis calibrator employing a 50-ohm coaxial cable and a 50-ohm terminator.

(3) Check that the flatness of the square wave displayed on the CRT screen is 3% or better.

(4) Set the VERT MODE switch to CH2.

(5) Set CH2 to 10 mV/DIV and apply to it a quality square wave signal of approximately 1 kHz with an amplitude for approximately 5 DIV from a vertical axis calibrator employing a 50-ohm coaxial cable and a 50-ohm terminator.

(6) Check that the flatness of the square wave displayed on the CRT screen is 3% or better.

k) Input Attenuator Frequency Response Check

(1) Set the front panel controls as shown in Table 4-1.

(2) Apply to CH1 input a quality square wave signal of approximately 1 kHz with an amplitude for approximately 5 DIV from a vertical axis calibrator employing a 50-ohm coaxial cable and a 50-ohm terminator.

(3) Check that the flatness of the square wave displayed on the CRT screen is 3% or better.

(4) Set the CH1 input sensitivity (VOLTS/DIV) to 10 mV/DIV.

(5) Adjust the displayed waveform amplitude to 5 DIV by adjusting the output of the vertical axis calibrator.

(6) Check that the flatness of the displayed waveform is 3% or better as in the case of (3).

(7) At each range of CH1, check that the flatness of the displayed waveform is 3% or better.

(8) Set the VERT MODE switch to CH2.

(9) At each range of CH2, check that the flatness of the displayed waveform is 3% or better.

1) Vertical-axis High-frequency Response Check

(1) Set the front panel controls as shown in Table 4-1.

(2) Set the TIME/DIV switch to 0.2μS.

(3) Set CH1 to 10 mV/DIV and apply to it a quality square wave signal of approximately 1 MHz with an amplitude for approximately 5 DIV from a vertical axis calibrator employing a 50-ohm coaxial cable and a 50-ohm terminator.

(4) Check that the flatness of the square wave displayed on the CRT screen is 3% or better.

(5) Set the VERT MODE switch to CH2.

(6) Set CH2 to 10 mV/DIV and apply to it a quality square wave signal of approximately 1 MHz with an amplitude for approximately 5 DIV from a vertical axis calibrator employing a 50-ohm coaxial cable and a 50-ohm terminator.

(7) Check that the flatness of the square wave displayed on the CRT screen is 3% or better.

4.2.2 Trigger Operation Check

a) TRIG SOURCE Check

(1) Set the front panel controls as shown in Table 4-1.

(2) Apply to the CH1 input a 50-kHz signal with an amplitude for 4 DIV on the screen from a signal generator and set the TIME/DIV switch to 10μS.

(3) Check that the displayed waveform is stationary without any jitter or other undesirable phenomena.

(4) Change application of the signal generator output to the CH2 input and change the VERT MODE switch to CH2.

(5) Check that the displayed waveform is stationary without any jitter or other undesirable phenomena.

(6) Set the TRIG SOURCE switch to LINE.

(7) Apply the LINE signal to CH1 or CH2 and set the TIME/DIV switch to 5mS/DIV.

(8) Check that the displayed waveform is stationary without any jitter or other undesirable phenomena.

(9) Set the TRIG SOURCE switch to EXT.

(10) As is the case of (2), apply to the CH1 input a 50-kHz signal from a signal generator and set the TIME/DIV switch to 10μS/DIV.

(11) Apply to the EXT input the output signal of the CH1 SIGNAL OUT terminal at the rear of the oscilloscope.

(12) Check that the displayed waveform is stationary without any jitter or other undesirable phenomena.

b) TRIG COUPLING Check

(1) Set the front panel controls as shown in Table 4-1.

(2) Apply to the CH1 input an amplitude calibration signal of 2 DIV from a vertical axis calibrator.

(3) Adjust the triggering level with the TRIG LEVEL control so that the CH1 waveform is displayed stationary (set the triggering level at a mid-position of the waveform).

(4) Check that, even when the signal applied to the CH1 input is increased to 4 DIV, the waveform displayed on the CRT screen is properly triggered and stationary and that the triggering point is slightly shifted.

(5) Set the TRIG COUPLING switch to DC.

(6) Apply to the CH1 input an amplitude calibration signal of 2 DIV from a vertical axis calibrator.

(7) Adjust the triggering level with the TRIG LEVEL control so that the CH1 waveform is displayed stationary (set the triggering level at a mid-position of the waveform).

(8) Check that, even when the signal applied to the CH1 input is increased to 4 DIV, the waveform displayed on the CRT screen is properly triggered and stationary and that the triggering point is slightly shifted.

(9) Set the TRIG COUPLING switch to AC.

(10) Apply to the CH1 input a 1-MHz signal with an amplitude for 4 DIV from a signal generator.

(11) Set the TIME/DIV switch to 1μS and adjust the TRIG LEVEL control so that triggering is stably done and the displayed waveform can be easily observed.

(12) Set the TRIG COUPLING switch to HF REJ and check that the triggering signal is attenuated and no triggering is effected.

(13) Set the TRIG COUPLING switch to TV.

(14) Apply a TV video signal with an amplitude for 4 DIV to the CH1 input and set the TRIG SLOPE switch to "-".

(15) Check that the TV V signal can be observed with the 0.1mS and lower ranges of the TIME/DIV switch and the TV H signal can be observed with the 0.5μS and higher ranges.

c) TRIG SLOPE Check

(1) Set the front panel controls as shown in Figure 4-1.

(2) Apply to the CH1 input an amplitude calibration signal with an amplitude for 4 DIV from a vertical axis calibrator.

(3) Turn clockwise the TRIG LEVEL control to a point where triggering is properly effected and the CH1 waveform is displayed stationarily.

(4) Check that the displayed waveform is properly triggered by the "+" slope.

(5) Set the TRIG SLOPE switch to "-".

(6) Check that the displayed waveform is properly triggered by the "-" slope.

d) SWEEP MODE Check

(1) Set the front panel controls as shown in Table 4-1.

(2) Apply to the CH1 input a 50-kHz signal with an amplitude for 4 DIV from a signal generator.

(3) Gradually turning the TRIG LEVEL control clockwise, check that the display on the CRT screen changes from the FREE RUN mode to the mode triggered by "-" peaks, then to the mode triggered by "+" peaks, and then back to the FREE RUN mode.

(4) Set the CH1 INPUT COUPLING switch to GND so that the displayed signal waveform collapses and a straight line of trace is displayed.

(5) Set the SWEEP MODE switch to NORM and turn the TRIG LEVEL control to full counterclockwise.

(6) Gradually turning the TRIG LEVEL control clockwise, check that the display on the CRT screen changes from no signal to the mode triggered by "-" peaks, then to the mode triggered by "+" peaks, and then back to no signal.

(7) Set the CH1 INPUT COUPLING switch to GND and check that no signal is displayed on the CRT screen.

(8) Return the CH1 INPUT COUPLING switch to DC. Turn the TRIG LEVEL control so that triggering is effected.

(9) Set the SWEEP MODE switch to SINGLE.

(10) Set the CH1 INPUT COUPLING switch to GND.

(11) Press the SINGLE button (PUSH TO RESET). Check that the LED indicator at upper right of the SINGLE switch turns on indicating that the instrument is reset to the stand-by state for single-sweep operation.

(12) Return the CH1 INPUT COUPLING to DC.

(13) Check that, as an input signal is applied, triggering is effected only once for single-sweep operation.

4.2.3 Horizontal Axis Operation Check

a) SWEEP TIMING Check

(1) Set the front panel controls as shown in Table 4-1.

(2) Apply to the CH1 input a time marker signal with an amplitude for about 2 DIV from a time marker generator.

(3) Changing the SWEEP/DIV switch of the oscilloscope and changing accordingly the time marker signal frequency of the marker generator, check that the sweep time accuracy of each range is within ±3%.

(4) Set the PULL ×10 MAG switch to the ON state and check that the sweep time accuracy of each range is within ±5% (except the 0.5μS/DIV range in which case the accuracy may be within ±8%).

b) SWEEP VARIABLE Check

(1) Set the front panel controls as shown in Table 4-1.

(2) Apply to the CH1 input a time marker signal with an amplitude for about 2 DIV from a time marker generator.

(3) Turn the SWEEP VARIABLE control to the full counterclockwise position and check that the sweep time is made longer by 2.5 times or more.

c) Horizontal Axis Sensitivity Check (for X-Y Mode)

(1) Set the TIME/DIV switch to X-Y or CH3 HOR, the TRIG SOURCE switch to EXT, the TRIG COUPLING switch to DC, and the VERT MODE switch to CH2 (X-Y).

(2) Apply to the EXT input an amplitude calibration signal of 1 Vp-p from a vertical axis calibrator and check that the horizontal amplitude of the display on the CRT screen is approximately 10 DIV.

(3) Set the TRIG SOURCE switch to CH1 (X-Y) and the CH1 input sensitivity to 10mV.

(4) Apply to the CH1 input an amplitude calibration signal of 100 mVp-p from a vertical axis calibrator and check that the horizontal amplitude of the display on the CRT screen is 10.0 ±0.4 DIV.

d) Horizontal Axis (X-Y Operation) Phase and Frequency Response Check

(1) Set the TIME/DIV switch to X-Y or EXT HOR, the TRIG SOURCE switch to EXT, the TRIG COUPLING switch to DC, and the VERT MODE switch to CH2 (X-Y).

(2) Set the CH2 input sensitivity to 0.1V.

(3) Apply a signal generator output of 50 kHz, 0.8 Vp-p to both EXT and CH2 inputs.

(4) Gradually increasing the output frequency of the signal generator, check that phase difference within 50 kHz is within ±3 degrees.

(5) Set the TRIG SOURCE switch to CH1 (X-Y) and the CH1 input sensitivity to 0.1V.

(6) Apply a signal generator output of 50 kHz, 0.8 Vp-p to both CH1 and CH2 inputs.

(7) Gradually increasing the output frequency of the signal generator, check that phase difference within 50 kHz is within ±3 degrees.

(8) Apply a signal generator output of 50 kHz, 1.0 Vp-p to the CH1 input alone.

(9) Gradually increase the output frequency of the signal generator and check that the horizontal frequency response at 2 MHz is -3 dB or better.

e) Horizontal Position Check

(1) Set the front panel controls as shown in Table 4-1.

(2) Apply to the CH1 input a 1-msec time marker signal with an amplitude for 2 DIV from a time marker generator.

(3) Align the left-hand end of the sweep with that of the graticule by adjusting the HOR POSITION control.

(4) Set the TIME/DIV switch to X-Y or EXT HOR and check that the beam spot is within ±1 DIV from the center of the CRT screen.

4.2.4 Storage Circuit Operation Check

a) Storage Function Check

(1) Set the front panel controls as shown in Table 4-1. Turn the TIME/DIV switch to 1s/DIV.

(2) Press the STORAGE switch to turn on the storage function. (If the intensity is too bright when this is done, reduce the intensity with the INTEN control.)

(3) Turning the VERT POSITION control, check that the locus of beam spot movement is recorded on the CRT screen.

b) Erase Function Check

(1) Set the front panel controls as described in (1) and (2) of a) above.

(2) Press the ERASE switch and check that the CRT screen illuminates ones and the CRT screen is erased entirely.

c) Auto Erase Function Check

(1) Set the front panel controls as shown in Table 4-1.

(2) Press the STORAGE switch to turn on the storage function. Slightly turn the AUTO ERASE INTERVAL control clockwise to turn on the auto erase function.

(3) Turn further the AUTO ERASE INTERVAL control clockwise and check that the trace on the CRT screen is displayed with repetitions of write, retain, and erase.

d) Enhance Function Check

(1) Set the front panel controls as described in (1) and (2) of c) above.

(2) Turn clockwise the AUTO ERASE INTERVAL control to a point that the trace on the CRT screen is retained for 1 - 2 seconds.

(3) Increase the sweep speed by turning the TIME/DIV switch step by step to the range where the trace is not written any longer.

(4) Turn on the ENHANCE switch and slowly turn the ENHANCE LEVEL control clockwise and check that the trace of (3) appears again when the control is turned to a point where overall CRT screen becomes slightly bright.

4.3 Calibration

4.3.1 General

It is most recommendable to calibrate periodically the oscilloscope for overall items. When a particular item is of a special interest however, such item alone may be calibrated. For examples, if the measuring time accuracy is of a special interest, the time base alone may be calibrated or, if the vertical sensitivity is of a special interest, the vertical axes alone may be calibrated. Note that overall items may be required to be calibrated when the oscilloscope is repaired, depending on the nature of repair. Accurate calibration of the oscilloscope calls for accurate calibration instruments and special skills. It is most recommendable to order your Kikusui agent for calibration.

4.3.2 Calibration Instruments and Devices

Instruments and devices which may be needed for calibration are shown in Table 4-3. Some of them may not be needed depending on the type of calibration. However, the instruments and devices used for calibration must be accurate and reliable ones.

Table 4-3

Instrument	Performance	Remarks
Digital voltmeter (1) (low voltages)	Measuring range: 0 - 500 V Measuring accuracy: ±0.1% or better	To check circuit voltages
Digital voltmeter (2) (high voltages)	Measuring range: 0 - 10 kV Measuring accuracy: ±1% or better	To check acceleration voltages
Capacitance meter	Measuring range: 0 - 50 pF Measuring accuracy: ±3% or better	To check input capacitances
Ohmmeter	Measuring range: 0 - 2 MΩ Measuring accuracy: ±0.5%	To check input resistances
Vertical axis calibrator		
Amplitude calibrator	Output voltage: 1 mV - 50 Vp-p Output accuracy: ±0.3% or better	Square wave of approximately 1 kHz. To calibrate vertical axis and X-Y amplitude
Square wave characteristic calibration	Output waveform: Square wave Output frequency: 10 Hz - 1 MHz Rise time: 1.0 nS or faster Flatness: ±0.5% or better	To adjust flatness of square wave
Time marker generator	Marker output: 5 S - 2 nS Output stability: ±0.1% or better	To calibrate time base
Signal generator	Frequency range: 250 kHz - 100 MHz Frequency accuracy: ±1% or better Output voltage: 5 mV - 5.5 Vp-p Output flatness: ±2% or better	To calibrate vertical axis and X-Y frequency. With reference to 50 kHz
Cables	Characteristic impedance: 50 Ω Length: About 1 meter	Two or more
Terminators	Characteristic impedance: 50 Ω Wattage: 1/2 W or more	Two or more
Attenuator	Characteristic impedance: 50 Ω Wattage: 1/2 W or more	
Screwdriver	Size: 3 mm	
Control screwdriver	Low capacitance type	

4.3.3 Calibration Procedure

For efficient calibration, the oscilloscope should be calibrated in a proper sequence. The subsequent paragraphs are written in such sequence. Be sure to observe the sequence in order to calibrate the oscilloscope efficiently and reliably.

When a certain item alone is required to be calibrated, however, you may start calibration by the required item provided that the procedures of a) Check and Adjustment of DC Supply Voltages and b) Adjustment of CRT Circuits are completed beforehand.

a) Check and Adjustment of DC Supply Voltages

Before calibrating the oscilloscope, its DC supply voltages should be checked and adjusted. Check and adjust the +12V supply voltage first and the other supply voltages next. The supply voltages are shown in Table 4-4 and the test points and controls are indicated in Figure 4-3.

Table 4-4

Nominal voltage	Tolerance	Check and adjustment points
+5 V	+4.75 to +5.25 V	
+12 V	+11.95 to +12.05 V	RV606 (Figure 4-3)
-12 V	-11.80 to -12.20 V	
+145 V	+140 to +150 V	
-150 V	-145 to -155 V	
-3 kV	-2.85 to -3.15 kV	

For voltage check, measure the voltage between test point and ground using a precision digital voltmeter. The +12V supply must be especially carefully adjusted because it provides a reference for other supplies. To measure the -3000V supply whose internal impedance is high, use a voltmeter which as a sufficiently high input impedance (10 MΩ or over).

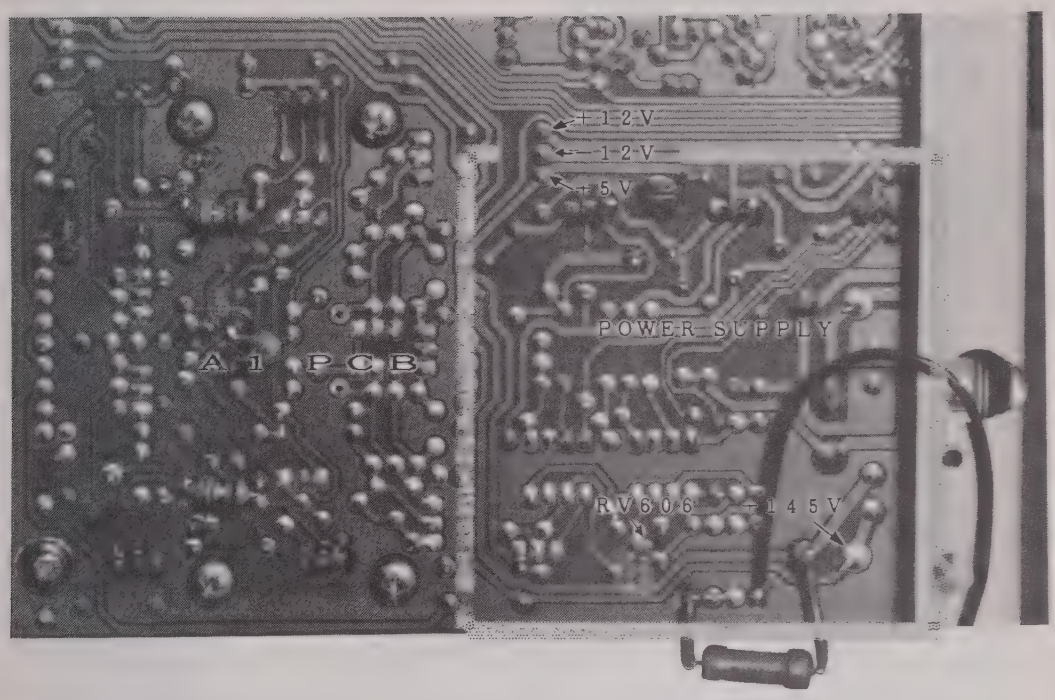


Figure 4-3. Test points and controls

Precautions: Because adjustments of supply voltages largely affect vertical sensitivity and horizontal sweep time, the oscilloscope must be re-calibrated as explained in the subsequent paragraphs.

b) Adjustment of CRT Circuits

Some adjustments of the CRT circuits directly affect the CRT deflection sensitivity as in the case of "Check and Adjustment of DC Supply Voltages" of the preceding paragraph.

o Adjustment of SUB INTEN:

This control is for adjusting the trace intensity and the operating position of the INTEN knob (4).

(1) Set the TIME/DIV switch (31) at 1 mS and display a single-line horizontal trace on the CRT screen.

(2) Set the white mark of the INTEN knob at the 10 o'clock position and adjust the SUB INTEN control (RV653) so that the trace is displayed on the screen with a barely discernible intensity.

o Adjustment of SUB-FOCUS:

This control is for adjusting the operating position of the FOCUS knob (6). With the FOCUS knob set with its white dot positioned upright (noon position), adjust the SUB-FOCUS control (RV651) so that the best focus is obtained.

o Adjustment of ASTIG:

This control is for focus adjustment of the electron lens of the CRT.

(1) Set the TIME/DIV switch (31) to the [X-Y | EXT HOR] position and display the beam spot in the center of the CRT screen with the POSITION controls.

(2) Turn the FOCUS control (6) to an appropriate position and then adjust the ASTIG control (RV652) so that the shape of the displayed beam spot becomes as true circle as possible.

c) Adjustment of Vertical Axes

o Adjustment of STEP BAL:

This control is for minimizing the shift of trace when the VOLTS/DIV switch (12) or (16) is turned from the 5 mV position to the 10 mV position.

(1) Set the AC-GND-DC switch (10) or (19) to GND and display the trace on the CRT screen.

(2) Turning the VOLTS/DIV switch between 5 mV and 10 mV positions, adjust the STEP BAL control (RV101 or RV201) so that the shift of the trace becomes minimum.

o Adjustment of ×5 MAG BAL:

This control is for minimizing the shift of trace when the ×5 MAG switch (13) or (17) is changed.

(1) Set the AC-GND-DC switch (10) or (19) in the GND state and display a trace on the screen.

(2) Turning on and off the ×5 MAG switch, adjust the MAG DC BAL control (RV112 or RV212) so that the shift of the trace becomes minimum.

o Adjustment of VAR DC BAL:

This control is for minimizing the shift of the trace when the VARIABLE KNOB (13) or (17) is turned.

(1) Set the AC-GND-DC switch (10) or (19) to GND and display the trace on the CRT screen.

(2) Turning the VARIABLE knob, adjust the VAR DC BAL control (RV105 or RV205) so that the shift of the trace becomes minimum.

o Sensitivity calibration of CH1 and CH2:

Calibrate the sensitivity of the vertical amplifier to the value indicated by the VOLTS/DIV switch (12) or (16). For this calibration, use a square wave generator with an output voltage setting accuracy of 0.3% or better, at 1 kHz.

(1) Set the signal generator output at 50 mVp-p and apply the signal to the vertical input terminal (11) or (18).

(2) Set the VARIABLE knob (13) or (17) to the CAL'D position and set the VOLTS/DIV switch to the 10 mV range.

(3) Adjust the CH1 or CH2 GAIN control (RV110 or RV210) so that the amplitude of the displayed waveform becomes 5 DIV.

By the above procedure, other ranges also are calibrated to an accuracy of ±3% or better.

o Sensitivity calibration of ×5 MAG:

In a similar manner as for sensitivity calibration of CH1 and CH2, calibrate the sensitivity for the ×5 MAG function.

(1) Set the signal generator output at 8 mVp-p and apply the signal to the vertical input terminal (11) or (18).

(2) Set the VARIABLE knob (13) or (17) to the CAL'D position, set the VOLTS/DIV switch (12) or (16) to the 10 mV range, and pull out the CH1 ×5 MAG switch (13) or (17).

(3) Adjust the CH1 or CH2 GAIN control (RV102 or RV202) so that the amplitude of the displayed waveform becomes 5 DIV.

By the above procedure, other ranges also are calibrated to an accuracy of ±5% or better.

o Adjustment of ADD BAL:

With both CH1 and CH2 channels operating in a single-line horizontal trace state at the center of the screen, adjust this control so that the traces do not shift even when the VERT MODE switch is changed to the ADD mode.

(1) Set the AC-GND-DC switches (10) and (19) to GND and display the traces of the two channels overlapped at the center of the screen.

(2) Change the VERT MODE switch to the ADD state and adjust the ADD BAL control (RV301) so that the traces are positioned at the center of the screen.

o Adjustment of square wave characteristics of vertical amplifiers:

This adjustment is to adjust the square wave characteristics of the vertical amplifiers and to make their frequency response flat. This adjustment should be done with the 10 mV/DIV range which does not use the input attenuator, employing a square wave of 100 kHz and 1 MHz.

Adjustment should be done employing a quality square wave with a rise time of 1.0 nsec or faster, in the order of a middle frequency range first and a high frequency range next. Repeat the procedure for a few times.

(1) Adjustment of middle frequency range:

Set the VOLTS/DIV switch to 10 mV/DIV and the TIME/DIV switch to 20 μS/DIV. Apply a square wave of 1 MHz to the vertical input terminal and adjust the signal generator output so that the waveform is displayed with an amplitude of 4 DIV.

So that the waveform becomes as shown in Figure 4-4 (b), adjust RV302 and C331 first and RV109 and C171 (RV209 and C271 for CH2) next.

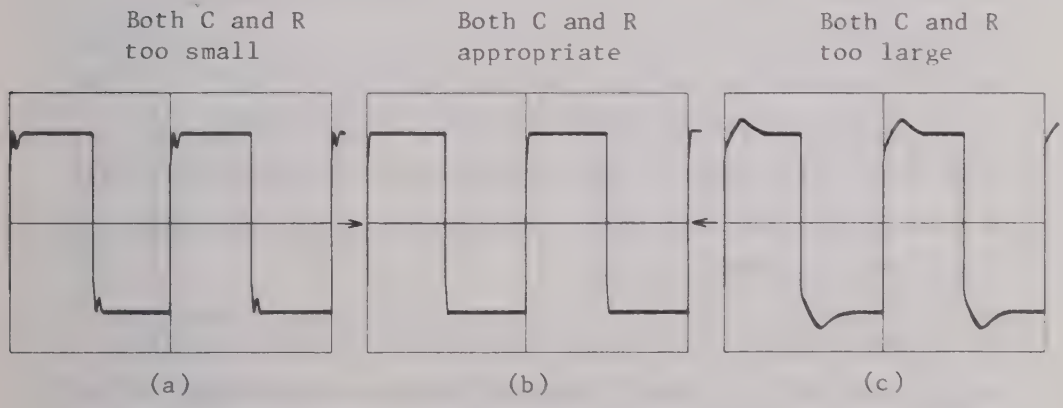


Figure 4-4

(2) Adjustment of high frequency range:

This adjustment is to make still more sharp the leading edge and reduce ringing at the leading edge of the pulse waveform which has been adjusted in step (1).

Adjust CH1 and CH2 to the same performance.

Change the TIME/DIV switch to 0.2 μS/DIV and expand the front edge of the pulse waveform which has been adjusted in step (1) "Adjustment of middle frequency range." Next, adjust RV103 and C131 (RV203 and C231 in the case of CH2) so that the leading edge of the pulse waveform becomes sharp.

Repeat the above adjustment so that flat square wave characteristics with sharp leading edge is obtained and the difference between CH1 and CH2 becomes minimum.

After the above adjustment is done, check again that the frequency response characteristics of both channels are satisfactory.

o Adjustment of input ATT of CH1 and CH2:

The VOLTS/DIV switch selects the oscilloscope sensitivity by switching the attenuator circuit consisting of the 1st attenuator (1/1, 1/10, 1/100 steps) and the 2nd attenuator (1/1, 1/2, 1/4, 1/10 steps). This procedure is for phase compensation and input capacitance adjustment of the attenuators. Adjustments should be done in the order of phase compensation first and input capacitance adjustment next.

Use a square wave signal generator which provides a quality square wave of rise time 1 μsec or faster, without sags or overshoots. Apply the signal for each of the ranges (0.1 V, 1 V) and display a waveform with an amplitude of 6 DIV. Adjust the phase compensation capacitors shown in the following table so

that an ideal waveform is displayed. Next, connect a low-capacitance C-meter to the input terminal and adjust the input-capacitance compensation capacitor so that the input capacitance at each range becomes 25 pF ±2 pF.

Compensation capacitor / Range	CH1		CH2	
	Phase compensation	Input capacitor	Phase compensation	Input capacitor
0.1 V (1/10)	C103	C102	C203	C202
1 V (1/100)	C106	C105	C206	C205

o Adjustment of CH1 SIGNAL OUTPUT DC OFFSET:

Note: This adjustment must be made after "Adjustment of CH1 TRIG OFFSET" of d) has been done.

This adjustment is to make zero the DC offset of the CH1 signal output with the DC OFFSET control.

(1) Apply the CH1 signal output to the CH2 input terminal using a coaxial cable.

(2) Display the CH2 input signal on the CRT screen and set the VOLTS/DIV switch to 10 mV.

(3) Changing the CH2 input coupling switch between GND and DC, adjust the CH1 SIGNAL DC OFFSET control RV108 so that shift of the trace becomes zero.

d) Adjustment of Trigger Circuit

o Adjustment of CH1 TRIG DC OFFSET:

This adjustment is for offsetting to zero the DC-component displacement of the CH1 internal trigger output.

(1) Apply a sinusoidal wave signal of approximately 1 kHz to the CH1 input terminal and set the AC-GND-DC switch to AC.

(2) Set the VERT MODE switch to CH1, set the INT TRIG switch to CH1 or ALT, and display the signal with an amplitude of 8 DIV on the CRT screen.

(3) Set the COUPLING switch to AC and adjust the LEVEL knob so that the trigger point is brought to the center of the displayed waveform amplitude.

(4) Change the COUPLING switch to DC and adjust the CH1 TRIG & X-AXIS DC OFFSET (RV107) so that the trigger point is brought to the center of the displayed waveform amplitude.

o Adjustment of CH2 TRIG DC OFFSET:

This adjustment is for offsetting to zero the DC-component displacement of the CH2 internal trigger output.

For this adjustment, adjust CH2 TRIG DC OFFSET (RV207) in a similar manner as in the case of "Adjustment of CH1 TRIG DC OFFSET."

e) Adjustment of Time Base

o Calibration of sweep time:

This adjustment is for calibrating the sweep time to the values indicated by the TIME/DIV switch (31). For this adjustment, use time marker signals of accurate time intervals of 1 msec and 1 μsec or use signals of accurate frequencies of 1 kHz and 1 MHz.

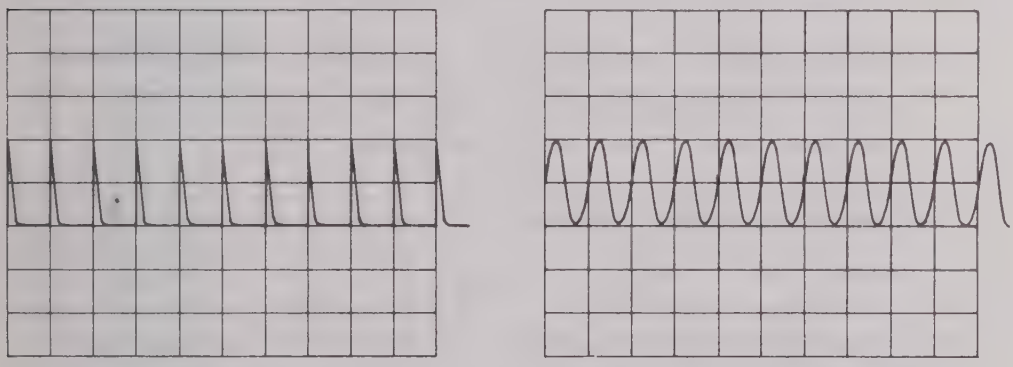
(1) Apply to the vertical input terminal a time marker signal of 1 msec or sinusoidal wave signal of 1 kHz and set the TIME/DIV switch (31) to 1 mS.

(2) Adjust the 1 mS CAL (RV405) so that the displayed signal waveform conforms with scale divisions of the graticule.

(3) Next, change the input signal to a 1-μsec time marker signal or a 1-MHz frequency signal and change the TIME/DIV switch (31) to 1 μS.

(4) Adjust RV404 so that the displayed signal waveform conform with scale divisions of the graticule.

When the above calibration is complete, the sweep speeds of the remaining ranges of the TIME/DIV switch (31) also are calibrated to an accuracy of ±2% or better.



Time marker signal　　Sinusoidal wave signal

Figure 4-5

f) Adjustment of Horizontal Axes (X-axis)

o Calibration of horizontal sensitivity:

This adjustment is for calibration of the X-axis sensitivity for X-Y operation.

After this adjustment is done, "Adjustment of CH1 SIGNAL OUTPUT DC OFFSET" of c) and "Adjustment of CH1 TRIG DC OFFSET" of d) must be done.

(1) Set at 100 mVp-p the output of the signal generator used for "Calibration of sensitivity" of c) and apply the output to the CH1 (X) input terminal (11).

(2) Set the TIME/DIV switch (31) to [X-Y | EXT HOR], the SOURCE switch (26) to [X-Y], the COUPLING switch (25) to DC, and the VERT MODE switch (14) to [X-Y].

(3) Adjust the X-GAIN control (RV106) so that the horizontal length of the trace becomes 10 DIV.

o Adjustment of X-Y POSITION:

This adjustment is for adjusting the positional relationship for the ↔ POSITION control when operation is switched between the NORM sweep mode and the [X-Y | EXT HOR] mode.

(1) Set the TIME/DIV switch (31) to 1 mS/DIV. Align the start point of the sweep with the left hand end of the CRT graticule with the ↔ POSITION control (32).

(2) Change the TIME/DIV switch (31) to [X-Y | EXT HOR] to select the X-Y mode.

(3) Adjust the X-AXIS DC OFFSET control (RV401) so that the beam spot is positioned at the center of the CRT screen.

g) Adjustment of Backing Electrode Voltage (Writing Speed)

In order that the maximum writing speed in the storage mode is maintained, the voltage of the storage target backing electrode of the CRT should be adjusted at every 100 hours or thereabout until the total run hour of the oscilloscope reaches approximately 400 hours.

(1) Set the TIME/DIV switch at 0.1 S/DIV and display the trace in the free run mode.

(2) Of the STORAGE MODE selector buttons, set the STORAGE button to the pushed-in position (▭) and the ENHANCE and HOLD buttons to the pushed-out position (□).

(3) Set the AUTO ERASE INTERVAL control at approximately 0.5 seconds.

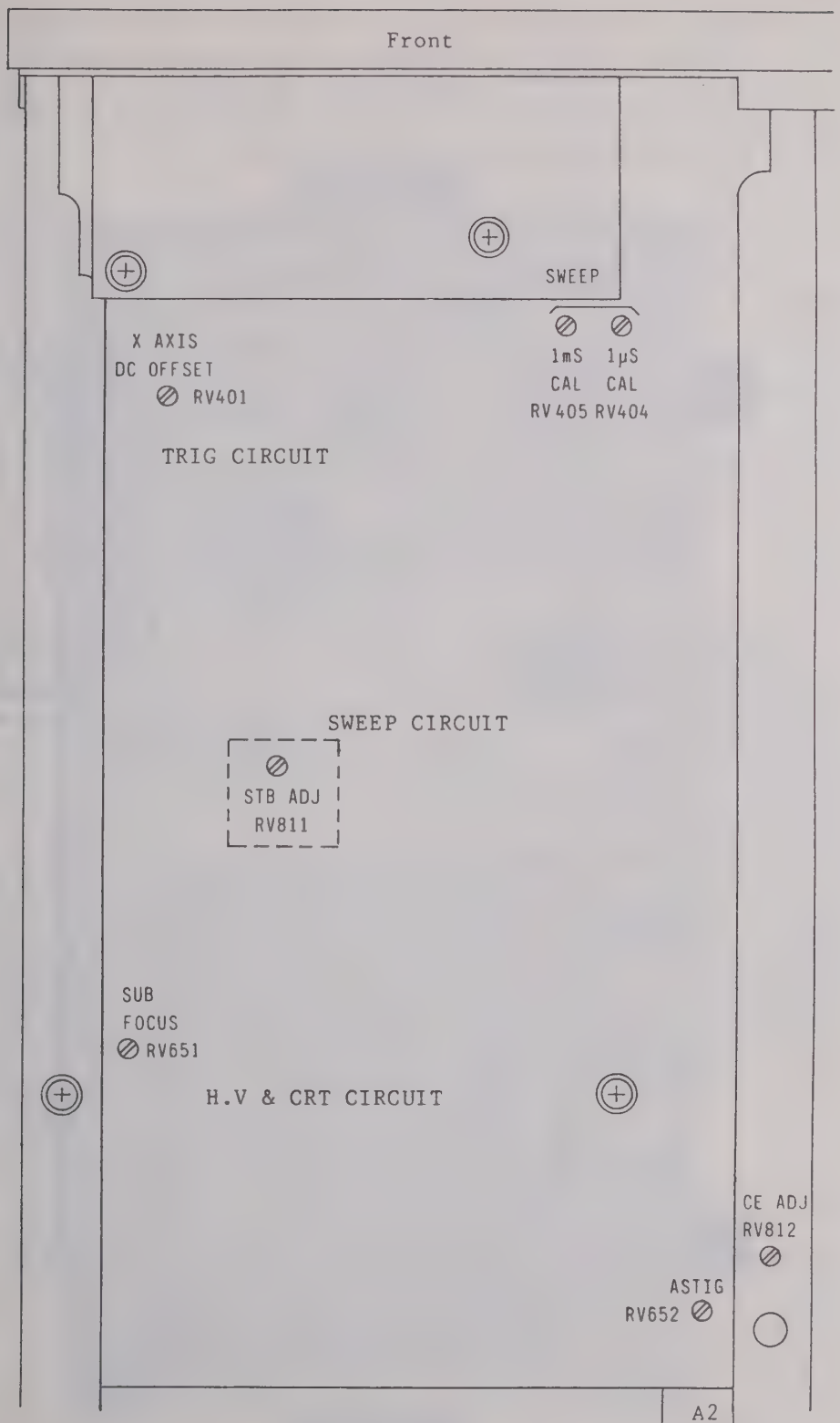
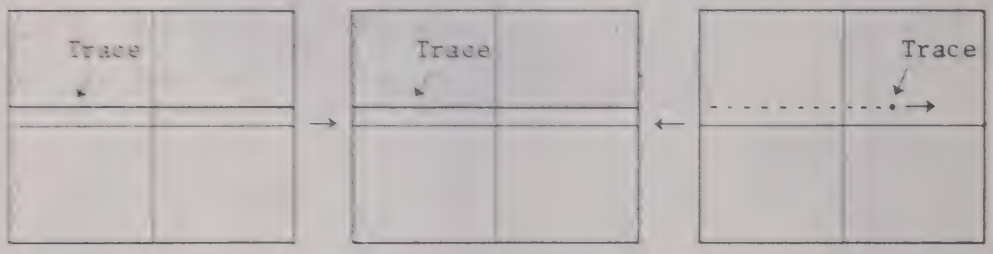


Figure 4-6 (UPPER PRINTED CIRCUIT BOARD)

(4) Adjust the backing electrode voltage with the backing electrode voltage adjustment potentionmeter (RV811) to a voltage immediately before the pheriphery of the CRT screen starts glowing (see Figure 4-6).

(5) Set the TIME/DIV switch to the 20 uS/DIV and confirm that the trace line is stored.



The backing electrode voltage is too high and the periphery glows.

Ideal

The backing electrode voltage is too low and the trace is not stored successfully.

Figure 4-7

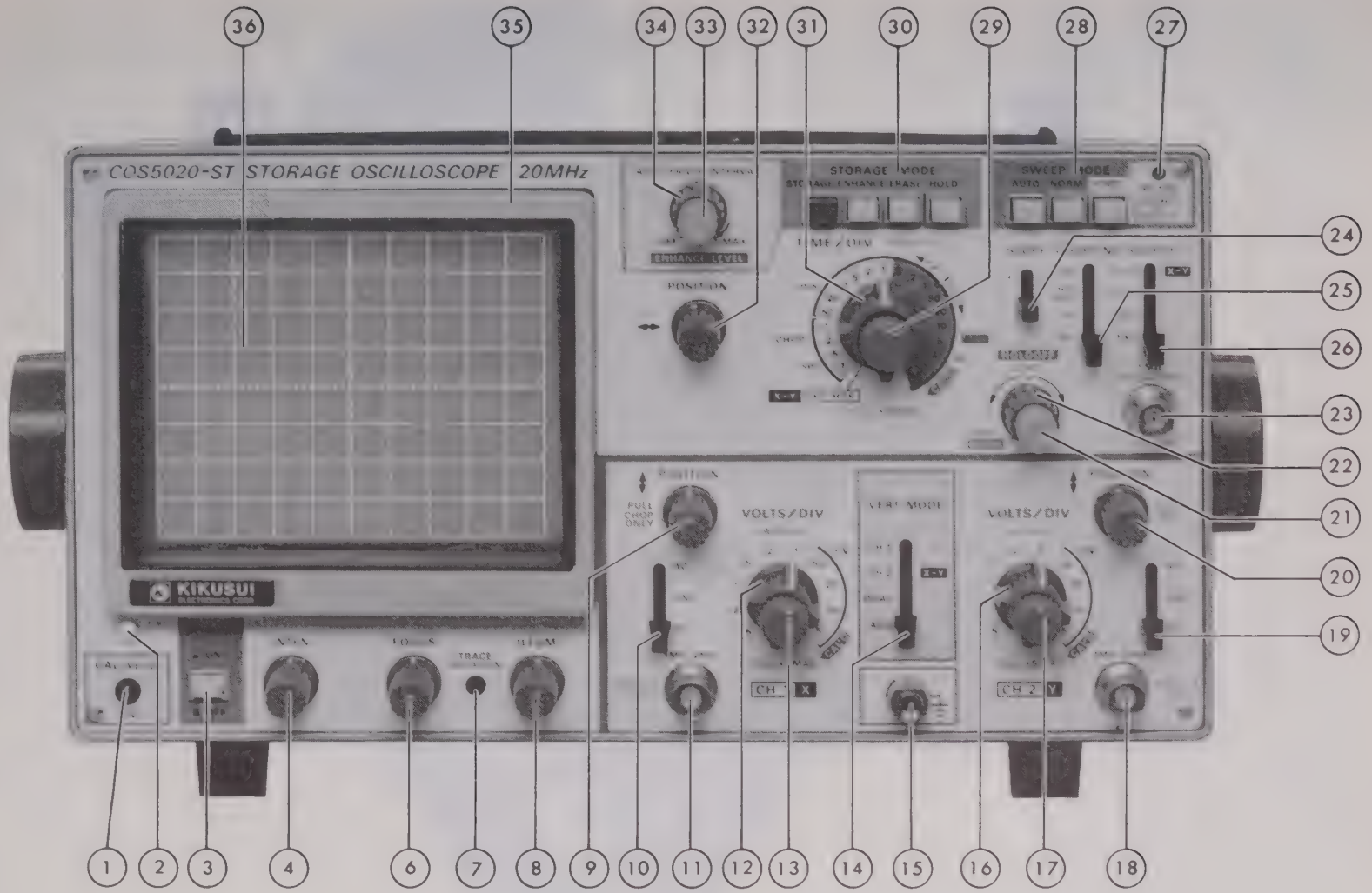

COS5020-ST STORAGE OSCILLOSCOPE 20MHz
KIKUSUI
STORAGE MODE
SWEEP MODE
VOLTS/DIV
VOLTS/DIV
CH 1 X
CH 2 Y
36
35
34
33
32
31
30
29
28
27
24
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Figure 4-8

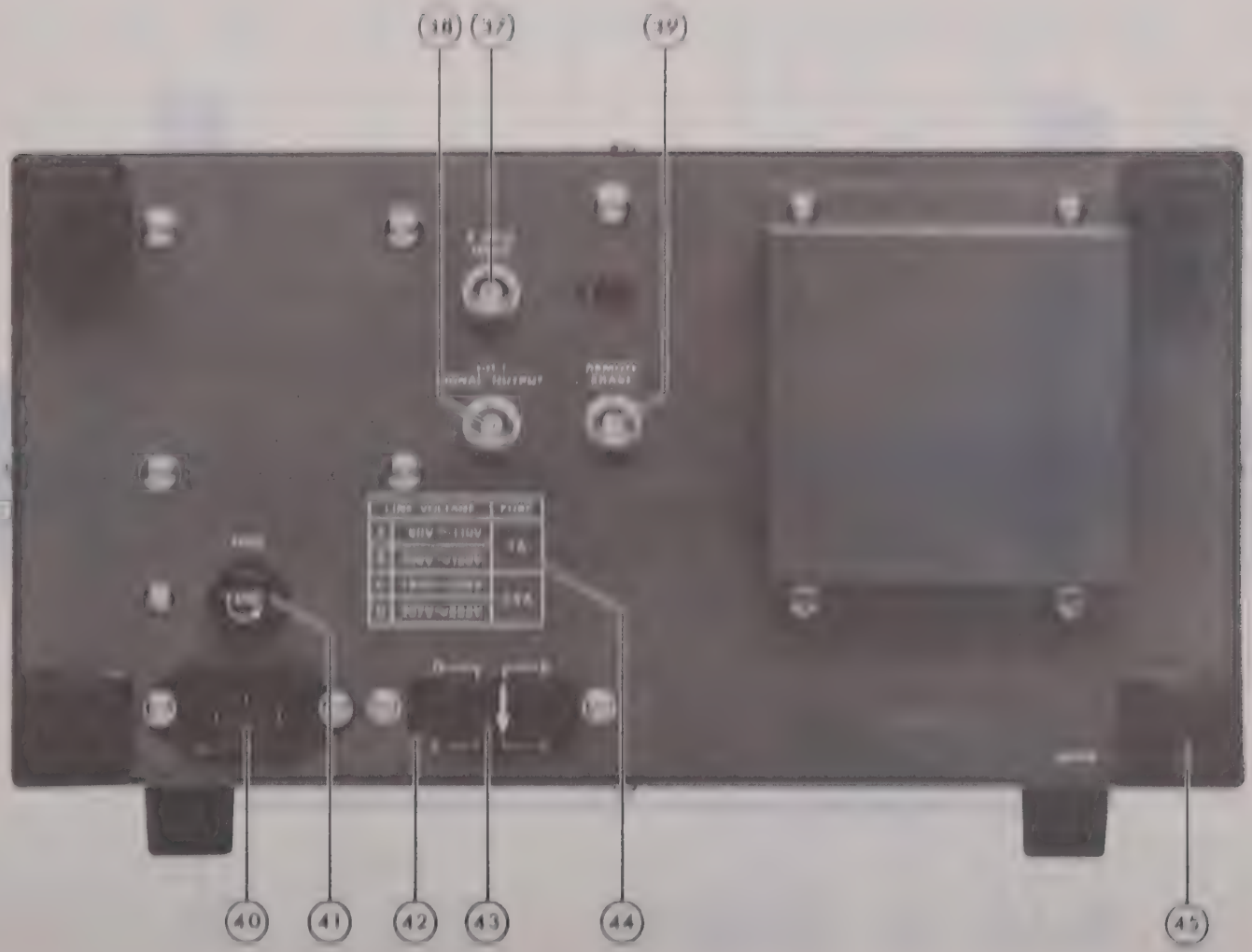


Figure 4-9

4.3.4 Location of Printed Circuit Boards

PCB	PARTS NO.	NAME
A1	90-50-3110	A1 VERT PREAMP & POWER SUPPLY
A2	90-50-3240	A2 SWEEP & H.V
A3	90-50-3230	A3 SWEEP & STORAGE MODE
OTHER 1	90-50-3100	CAL & CRT CONTROL
OTHER 2	90-50-3250	SUB CONTROL COS5020-ST

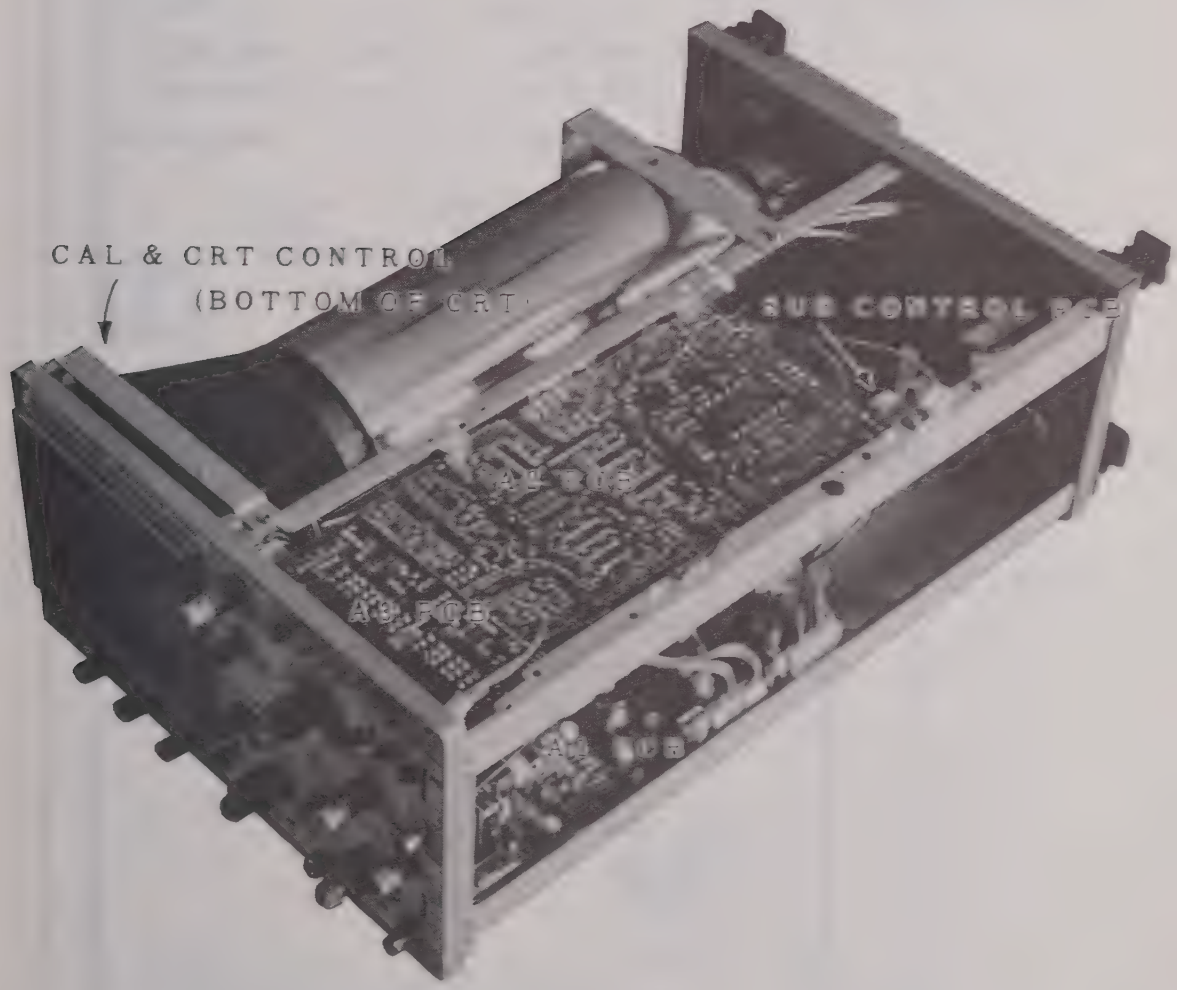


Figure 4-10

4.3.5 Location of Adjustment

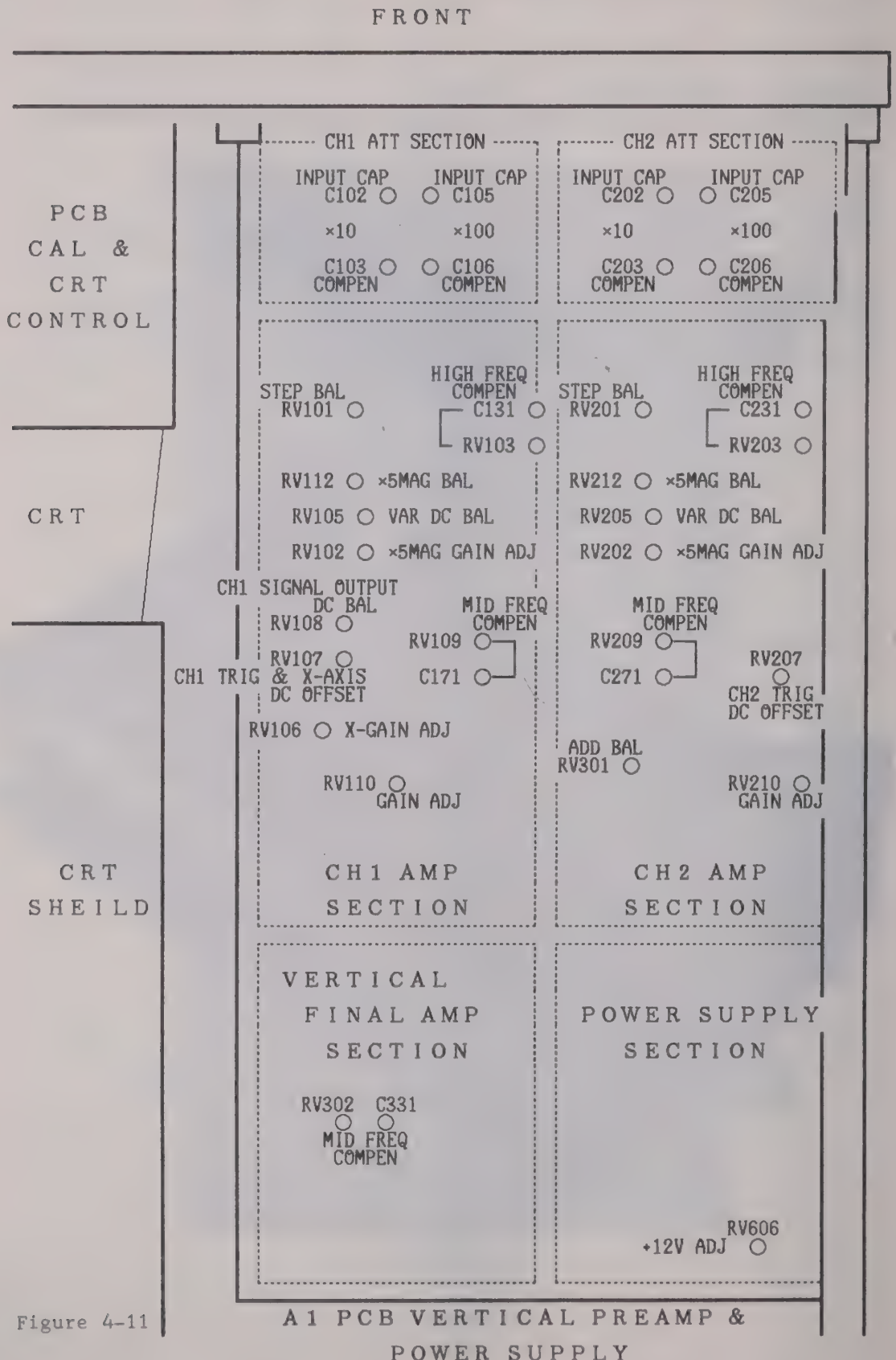


Figure 4-11 A1 PCB VERTICAL PREAMP & POWER SUPPLY

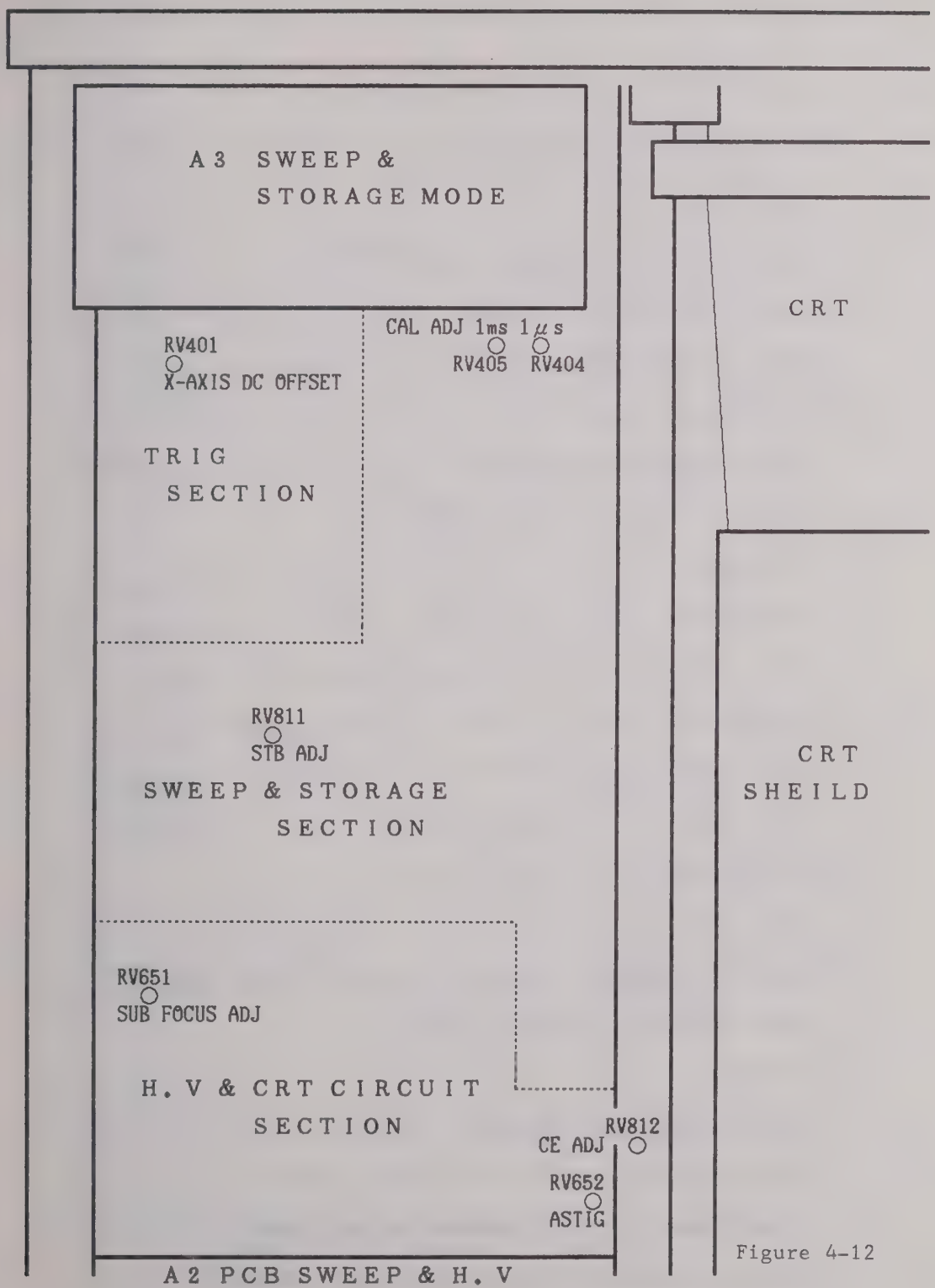

FRONT
A3 SWEEP &
STORAGE MODE
CRT
CAL ADJ 1ms 1μs
RV405 RV404
RV401
X-AXIS DC OFFSET
TRIG
SECTION
RV811
STB ADJ
SWEEP & STORAGE
SECTION
CRT
SHEILD
RV651
SUB FOCUS ADJ
H. V & CRT CIRCUIT
SECTION
RV812
CE ADJ
RV652
ASTIG
A2 PCB SWEEP & H. V

Figure 4-12

4.3.6 Check Sheet for Oscilloscope Calibration

Model COS5020-ST Oscilloscope Calibration Check Sheet

Serial No.: _____

I. External Appearance and Structure ..... ( )

II. Function Check ..... ( )

a) CRT SYSTEM (INTEN, FOCUS, ILLUM, B INTEN)

b) TRACE ROTATION (±3° or over)

c) VERT POSITION (CH1, CH2: ±8 DIV or over)

d) VERT VARIABLE (CH1, CH2: 1/2.5 or less)

e) INPUT COUPLING (AC, DC, GND)

f) VERT MODE (CH1, CH2, DUAL, ADD)

g) DC BALANCE (CH1, CH2: Within ±0.2 DIV)

h) STEP BALANCE (CH1, CH2: Within ±0.2 DIV)

i) VERT ×5 MAG BALANCE (CH1, CH2: Within ±1 DIV)

j) ADD BALANCE (Within ±0.5 DIV at center of screen)

k) PULL INVERT (CH2, INV BAL: Within 1 DIV)

l) TRIG SOURCE (CH1, CH2, LINE, EXT)

m) TRIG COUPLING (AC, HF REJ, TV, DC)

n) TRIG LEVEL SLOPE (+ and -)

o) HOLDOFF (Clockwise rotation for longer holdoff time)

p) SWEEP MODE (AUTO, NORMAL, SINGLE)

q) HORIZONTAL POSITION (±10 DIV or over)

r) HORIZONTAL ×10 MAG BALANCE (±1.0 DIV)

s) EXT Z AXIS (Negative polarity, DC - 5 MHz)

t) STORAGE MODE (STORAGE, ENHANCE, ERASE, HOLD)

u) ENHANCE (Clockwise rotation for higher enhance)

v) AUTO ERASE INTERVAL (1 - 30 sec)

III. Performance Check

o Vertical Axes

a) Input impedance: (1 MΩ ±10%, 25 pF ±2 pF in parallel; for both CH1 and CH2)..... ( )

b) Sensitivity accuracy: (±3% of set value [±5% when ×5 MAG], for each range; for both CH1 and CH2) ..... ( )

Range / Channel		mV/DIV				V/DIV					
		5	10	20	50	0.1	0.2	0.5	1	2	5
CH1											
CH2											
×5 MAG	CH1										
	CH2										

Unit: %

c) Frequency response: (20 MHz [15 MHz when ×5 MAG], within -3 dB, with reference to 50 kHz 8 DIV, for both CH1 and CH2) ..... ( )

CH1: DC - _____ MHz [DC - _____ MHz]

CH2: DC - _____ MHz [DC - _____ MHz]

Note: Low limit frequency of AC is 10 Hz.

d) Pulse wave characteristics ..... ( )

Channel	Range	Specification
CH1, CH2	10 mV/DIV	Overshoot: 5% or less Other distortions: 3% or less
	Other ranges than the above	Overshoot: 8% or less Other distortions: 6% or less

e) Common mode rejection ratio: (50:1 or over, with 50 kHz sine wave, with CH1 and CH2 set at the same sensitivity) ..... ( )

f) Crosstalk between channels (1000:1 at 50 kHz and 30:1 at 20 MHz, at 50 mV/DIV range) ..... ( )

g) Linearity: (Amplitude variation within ±0.1 DIV when 2.0 DIV waveform at center of screen is moved up or down on screen) ..... ( )

h) CH1 signal output: (100 mV with output open or
50 mV with output terminated
with 50 ohms, per 1 DIV amplitude
on screen) ..... ( )

o Trigger

a) Sensitivity ..... ( )

DC - 10 MHz	0.5 DIV	[0.10 V]
DC - 20 MHz	1.5 DIV	[0.20 V]
Video signal	2.0 DIV	[0.25 V]

[The values enclosed in the brackets are EXT trigger input sensitivities.]

Notes: The low limit frequency of AC is 10 Hz.

HF REJ attenuates the signals of higher than 50 kHz.

b) Level lock ..... ( )

Satisfies the above trigger sensitivity value plus 0.5 DIV [0.05 V] for a signal of 50 Hz - 40 MHz and duty ratio 20:80.

o Horizontal Axes

a) Sweep time accuracy: (±3%, all ranges) ..... ( )

Range	S/DIV			mS/DIV						
	0.5	0.2	0.1	50	20	10	5	2	1	0.5
Accuracy										

Range	mS/DIV		μS/DIV						
	0.2	0.1	50	20	10	5	2	1	0.5
Accuracy									

Unit: %

b) Linearity: (±3% [when ×5 MAG: ±5%]) ..... ( )

c) X-Y mode (CH1 for X axis and CH2 for Y axis)

o Sensitivity accuracy: (X axis: ±4% of set value
[±6% when ×5 MAG]

Y axis: ±3% of set value
[±5% when ×5 MAG] .... ( )

Range		mV/DIV				V/DIV					
Channel		5	10	20	50	0.1	0.2	0.5	1	2	5
X axis (CH1)											
Y axis (CH2)		The same as CH2 vertical axis									
5 MAG	X axis (CH1)										
	Y axis (CH2)	The same as CH2 vertical axis									

Unit: %

o Frequency response: (X axis: 500 kHz, within -3 dB, with reference to 50 kHz 8 DIV

Y axis: The same as CH2 vertical axis) ..... ( )

X axis: DC - _____ MHz

o Phase difference: (3 degrees or less between X and Y axes, DC - 50 kHz) ..... ( )

e) EXT horizontal operation

o Frequency response: (500 kHz, within -3 dB, with reference to 50 kHz 8 DIV) ..... ( )

DC - _____ MHz

o Phase difference: (3 degrees or less, within DC - 50 kHz) ..... ( )

o Z axis ..... ( )

Sensitivity: 3 Vp-p or over. Positive input for brighter trace and negative input for darker trace.

Frequency response: DC - 5 MHz

Input resistance: 5 kΩ ±10%

o Calibration signal ..... ( )

Signal waveform: Square wave

Duty ratio: 45:55

Voltage accuracy: 2 Vp-p ±2%

Frequency accuracy: 1 kHz ±5%

o Insulation resistance: (50 MΩ or over, between LINE and chassis, with 1000 VDC) ..... ( )

o Power consumption: (Approx. 40 VA) ..... _____ VA

IV. Test Conditions

Line voltage: _____ V

Line frequency: _____ Hz

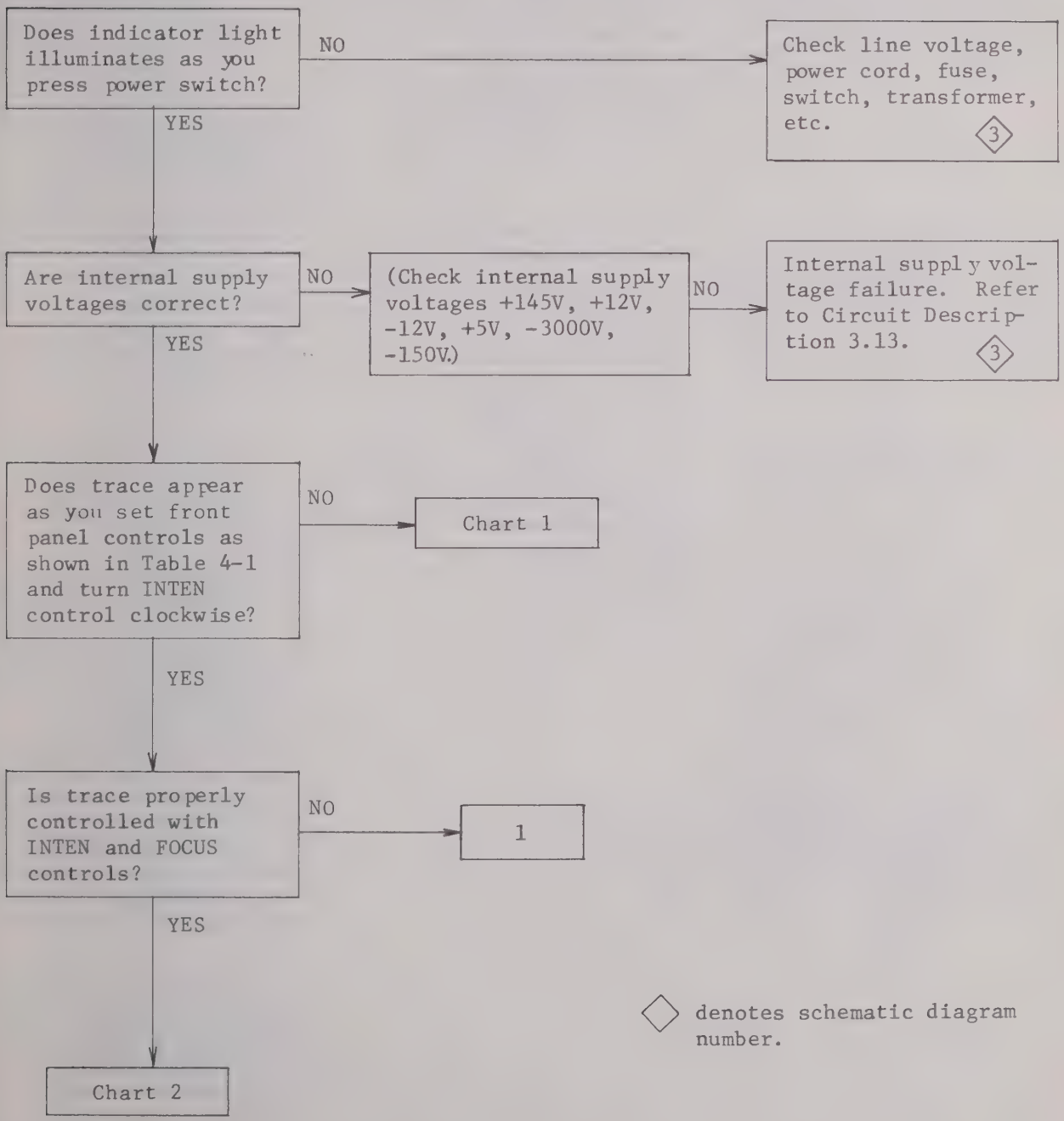
Test date: _____, 19___

Temperature and Humidity: _____°C, _____%

4.4 Troubleshooting

4.4.1 Troubleshooting Charts

When a trouble with the oscilloscope is found, check it referring to the following charts:


Does indicator light illuminates as you press power switch?
NO
Check line voltage, power cord, fuse, switch, transformer, etc.
3
YES
Are internal supply voltages correct?
NO
(Check internal supply voltages +145V, +12V, -12V, +5V, -3000V, -150V.)
NO
Internal supply voltage failure. Refer to Circuit Description 3.13.
3
YES
Does trace appear as you set front panel controls as shown in Table 4-1 and turn INTEN control clockwise?
NO
Chart 1
YES
Is trace properly controlled with INTEN and FOCUS controls?
NO
1
YES
Chart 2

◇ denotes schematic diagram number.

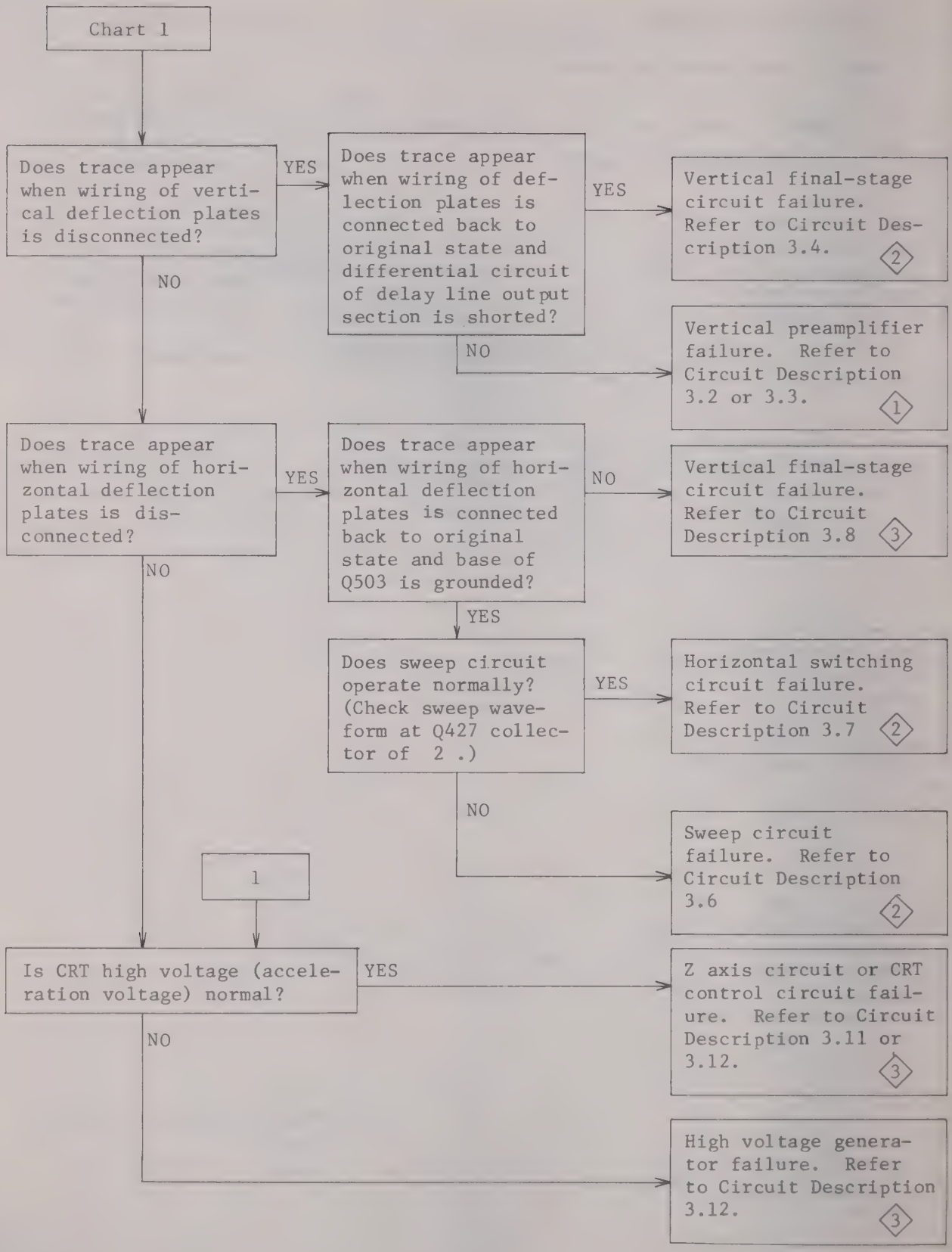


Chart 1
Does trace appear when wiring of vertical deflection plates is disconnected?
YES
Does trace appear when wiring of deflection plates is connected back to original state and differential circuit of delay line output section is shorted?
YES
Vertical final-stage circuit failure. Refer to Circuit Description 3.4.
2
NO
Vertical preamplifier failure. Refer to Circuit Description 3.2 or 3.3.
1
Does trace appear when wiring of horizontal deflection plates is disconnected?
YES
Does trace appear when wiring of horizontal deflection plates is connected back to original state and base of Q503 is grounded?
NO
Vertical final-stage circuit failure. Refer to Circuit Description 3.8
3
NO
YES
Does sweep circuit operate normally? (Check sweep waveform at Q427 collector of 2 .)
YES
Horizontal switching circuit failure. Refer to Circuit Description 3.7
2
NO
Sweep circuit failure. Refer to Circuit Description 3.6
2
1
Is CRT high voltage (acceleration voltage) normal?
YES
Z axis circuit or CRT control circuit failure. Refer to Circuit Description 3.11 or 3.12.
3
NO
High voltage generator failure. Refer to Circuit Description 3.12.
3

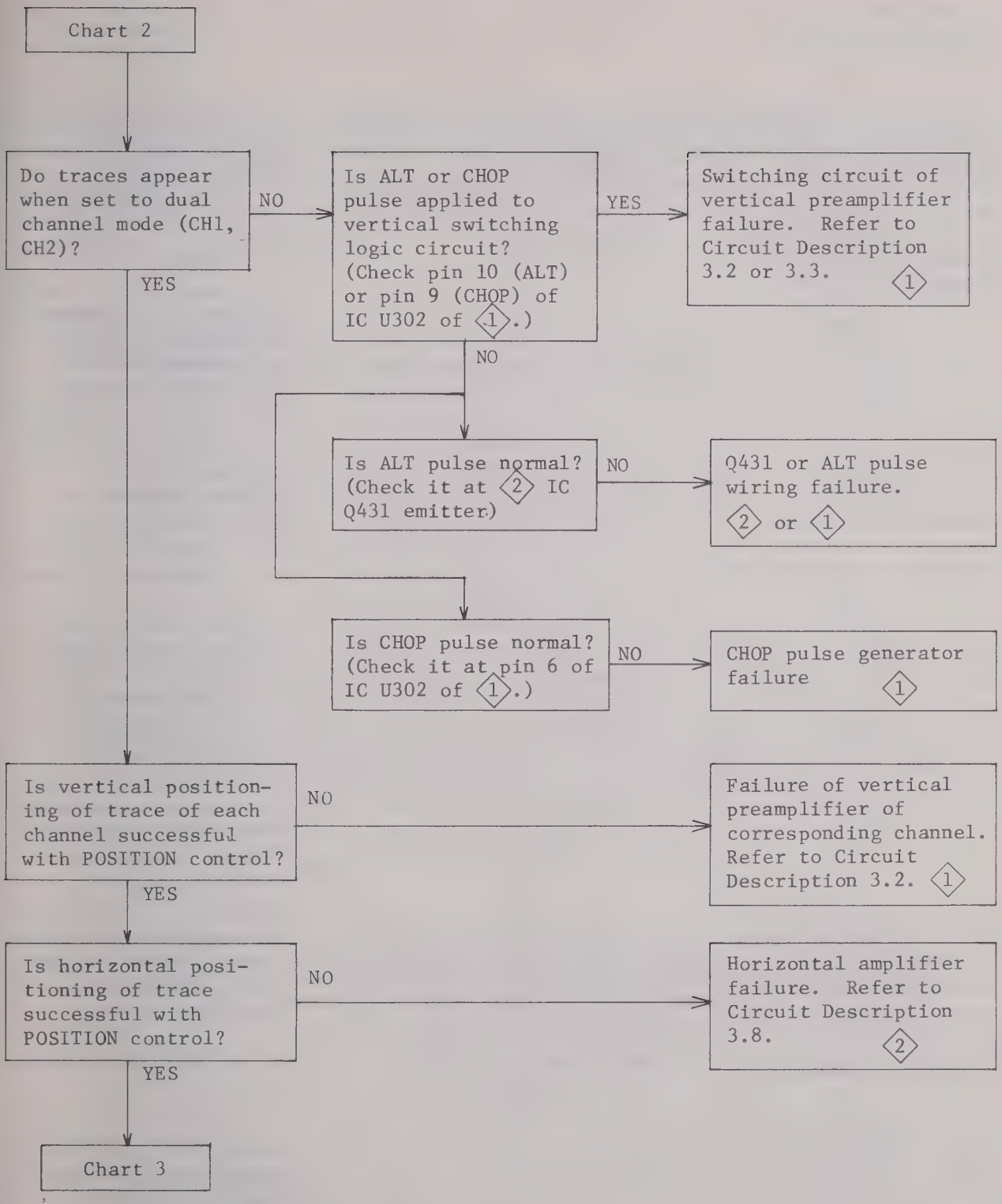


Chart 2
Do traces appear when set to dual channel mode (CH1, CH2)?
NO
YES
Is ALT or CHOP pulse applied to vertical switching logic circuit? (Check pin 10 (ALT) or pin 9 (CHOP) of IC U302 of ◇1.)
YES
Switching circuit of vertical preamplifier failure. Refer to Circuit Description 3.2 or 3.3. ◇1
NO
Is ALT pulse normal? (Check it at ◇2 IC Q431 emitter)
NO
Q431 or ALT pulse wiring failure. ◇2 or ◇1
Is CHOP pulse normal? (Check it at pin 6 of IC U302 of ◇1.)
NO
CHOP pulse generator failure ◇1
Is vertical positioning of trace of each channel successful with POSITION control?
NO
Failure of vertical preamplifier of corresponding channel. Refer to Circuit Description 3.2. ◇1
YES
Is horizontal positioning of trace successful with POSITION control?
NO
Horizontal amplifier failure. Refer to Circuit Description 3.8. ◇2
YES
Chart 3

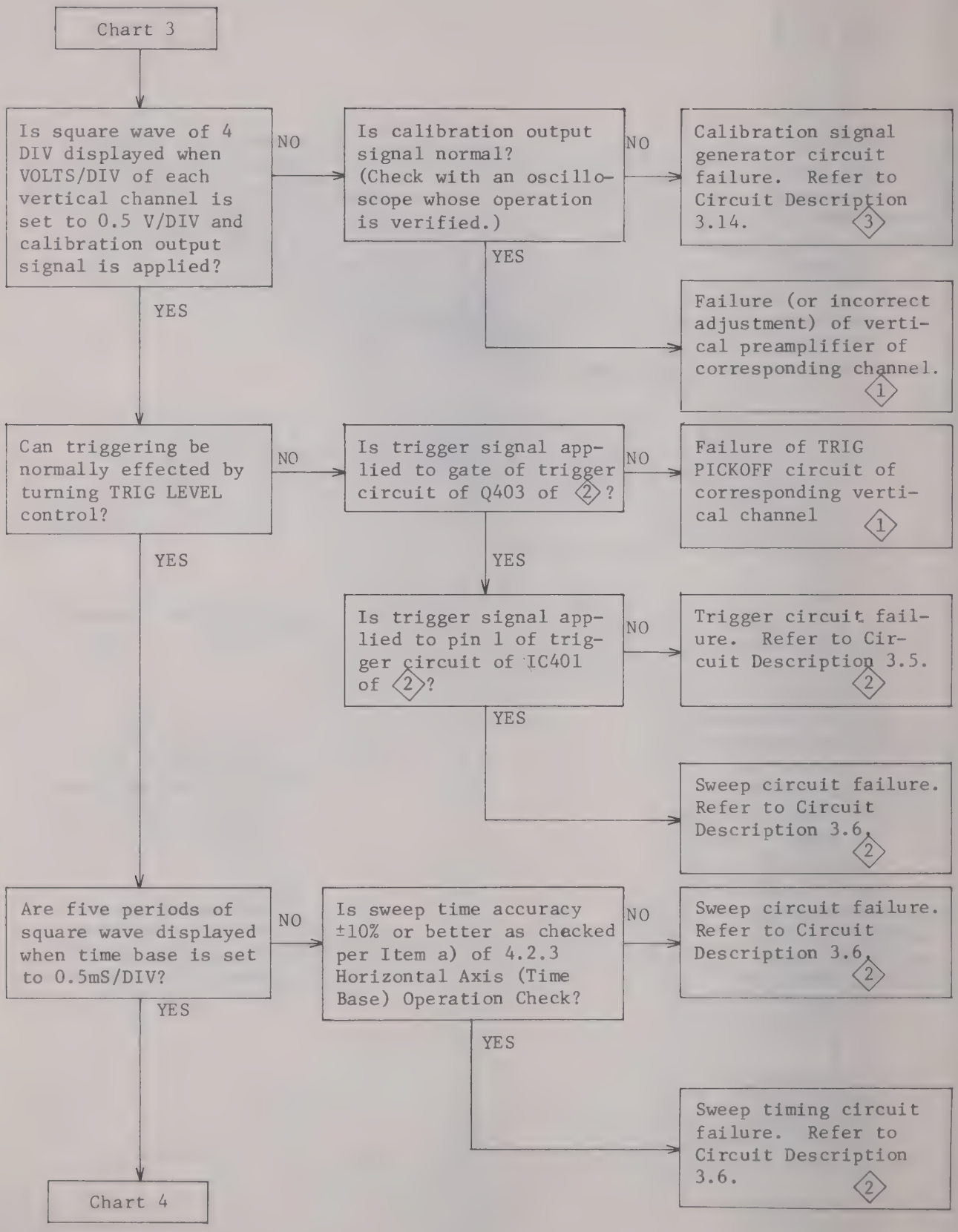


Chart 3
Is square wave of 4 DIV displayed when VOLTS/DIV of each vertical channel is set to 0.5 V/DIV and calibration output signal is applied?
NO
Is calibration output signal normal? (Check with an oscilloscope whose operation is verified.)
NO
Calibration signal generator circuit failure. Refer to Circuit Description 3.14. ◇3
YES
Failure (or incorrect adjustment) of vertical preamplifier of corresponding channel. ◇1
YES
Can triggering be normally effected by turning TRIG LEVEL control?
NO
Is trigger signal applied to gate of trigger circuit of Q403 of ◇2?
NO
Failure of TRIG PICKOFF circuit of corresponding vertical channel ◇1
YES
YES
Is trigger signal applied to pin 1 of trigger circuit of IC401 of ◇2?
NO
Trigger circuit failure. Refer to Circuit Description 3.5. ◇2
YES
Sweep circuit failure. Refer to Circuit Description 3.6. ◇2
Are five periods of square wave displayed when time base is set to 0.5mS/DIV?
NO
Is sweep time accuracy ±10% or better as checked per Item a) of 4.2.3 Horizontal Axis (Time Base) Operation Check?
NO
Sweep circuit failure. Refer to Circuit Description 3.6. ◇2
YES
YES
Sweep timing circuit failure. Refer to Circuit Description 3.6. ◇2
Chart 4

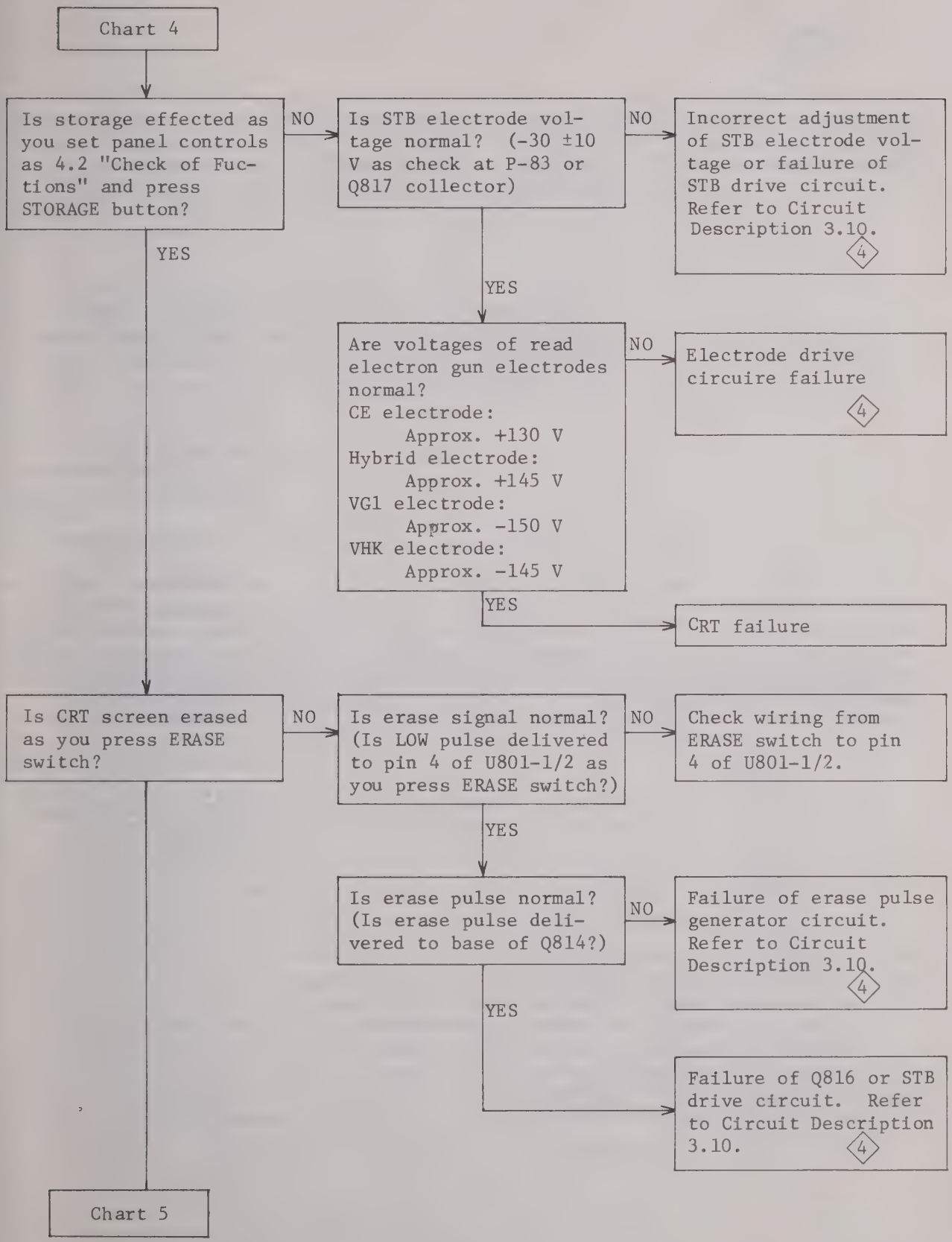


Chart 4
Is storage effected as you set panel controls as 4.2 "Check of Fuctions" and press STORAGE button?
NO
Is STB electrode voltage normal? (-30 ±10 V as check at P-83 or Q817 collector)
NO
Incorrect adjustment of STB electrode voltage or failure of STB drive circuit. Refer to Circuit Description 3.10.
4
YES
YES
Are voltages of read electron gun electrodes normal?
CE electrode:
Approx. +130 V
Hybrid electrode:
Approx. +145 V
VG1 electrode:
Approx. -150 V
VHK electrode:
Approx. -145 V
NO
Electrode drive circuire failure
4
YES
CRT failure
Is CRT screen erased as you press ERASE switch?
NO
Is erase signal normal? (Is LOW pulse delivered to pin 4 of U801-1/2 as you press ERASE switch?)
NO
Check wiring from ERASE switch to pin 4 of U801-1/2.
YES
Is erase pulse normal? (Is erase pulse delivered to base of Q814?)
NO
Failure of erase pulse generator circuit. Refer to Circuit Description 3.10.
4
YES
Failure of Q816 or STB drive circuit. Refer to Circuit Description 3.10.
4
Chart 5

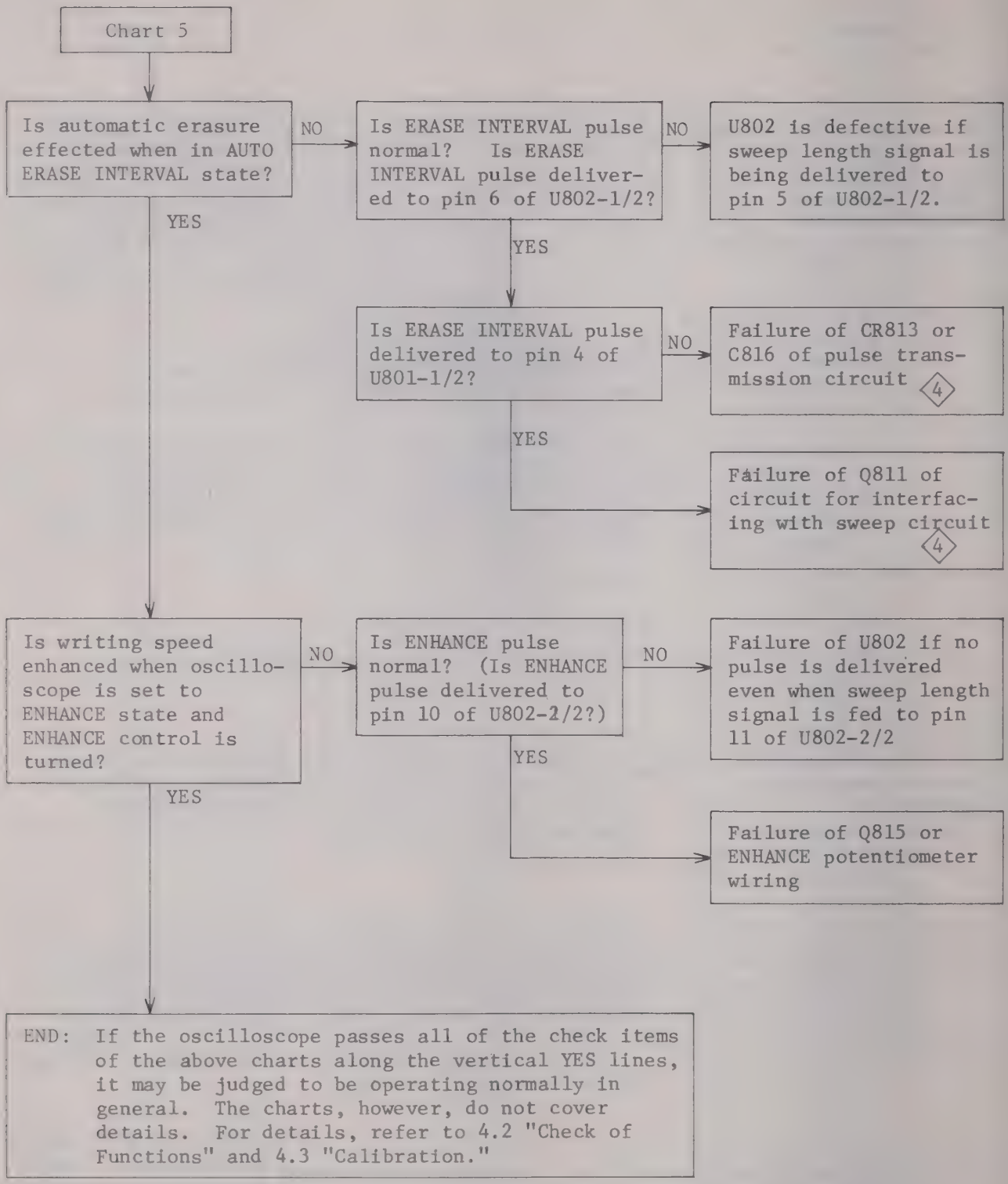
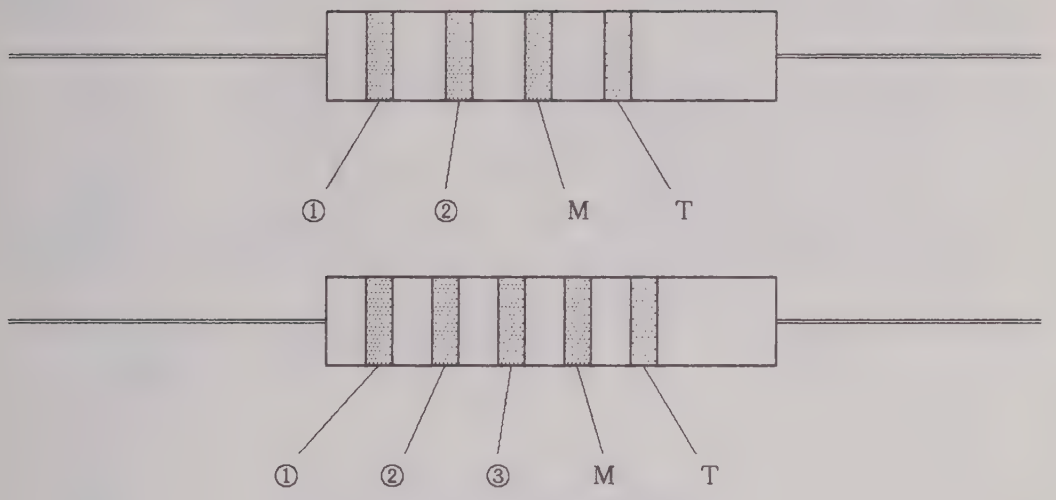


Chart 5
Is automatic erasure effected when in AUTO ERASE INTERVAL state?
NO
Is ERASE INTERVAL pulse normal? Is ERASE INTERVAL pulse delivered to pin 6 of U802-1/2?
NO
U802 is defective if sweep length signal is being delivered to pin 5 of U802-1/2.
YES
YES
Is ERASE INTERVAL pulse delivered to pin 4 of U801-1/2?
NO
Failure of CR813 or C816 of pulse transmission circuit 4
YES
Failure of Q811 of circuit for interfacing with sweep circuit 4
Is writing speed enhanced when oscilloscope is set to ENHANCE state and ENHANCE control is turned?
NO
Is ENHANCE pulse normal? (Is ENHANCE pulse delivered to pin 10 of U802-2/2?)
NO
Failure of U802 if no pulse is delivered even when sweep length signal is fed to pin 11 of U802-2/2
YES
YES
Failure of Q815 or ENHANCE potentiometer wiring
END: If the oscilloscope passes all of the check items of the above charts along the vertical YES lines, it may be judged to be operating normally in general. The charts, however, do not cover details. For details, refer to 4.2 "Check of Functions" and 4.3 "Calibration."

4.4.2 Resistor Color-code



① ② and ③ — 1st, and 2nd, and 3rd sigunificant figures

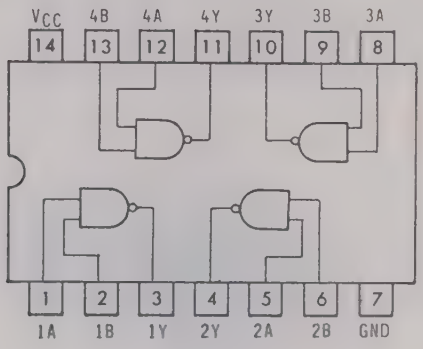
M — multiplier

T — tolerance

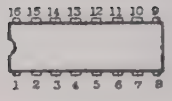
COLOR	SIGNIFICANT FIGURES	MULTIPLER	TOLERANCE
BLACK	0	1	———
BROWN	1	10	±1%
RED	2	10^2 or 100	±2%
ORANGE	3	10^3 or 1K	±3%
YELLOW	4	10^4 or 10K	±4%
GREEN	5	10^5 or 100K	±0.5%
BULE	6	10^6 or 1M	±0.25%
VIOLET	7	———	±0.1%
GRAY	8	———	———
WHITE	9	———	———
GOLD	—	10^{-1} or 0.1	±5%
SILVER	—	10^{-2} or 0.01	±10%
NONE	—	———	±20%

4.4.3 Semiconductor Lead Configurations

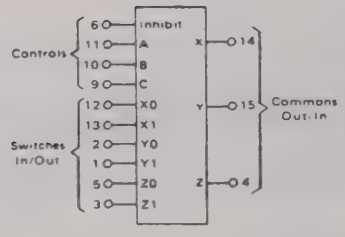
DIGITAL ICs



(TOP VIEW)
TC4011BP

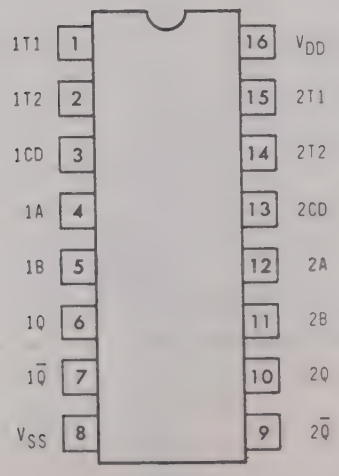


(TOP VIEW)



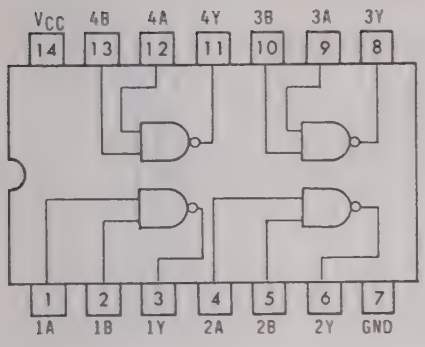
Control Inputs				ON Switches
	Select			
Inhibit	C*	B	A	MC14053B
0	0	0	0	Z0 Y0 X0
0	0	0	1	Z0 Y0 X1
0	0	1	0	Z0 Y1 X0
0	0	1	1	Z0 Y1 X1
0	1	0	0	Z1 Y0 X0
0	1	0	1	Z1 Y0 X1
0	1	1	0	Z1 Y1 X0
0	1	1	1	Z1 Y1 X1
1	x	x	x	None

TC4053BP

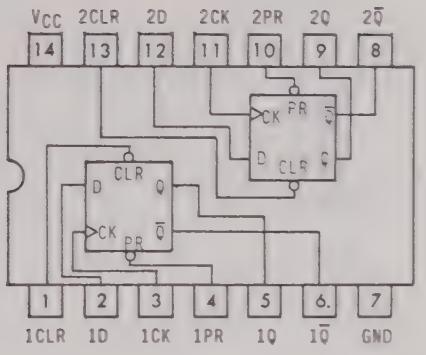


(TOP VIEW)
TC4528

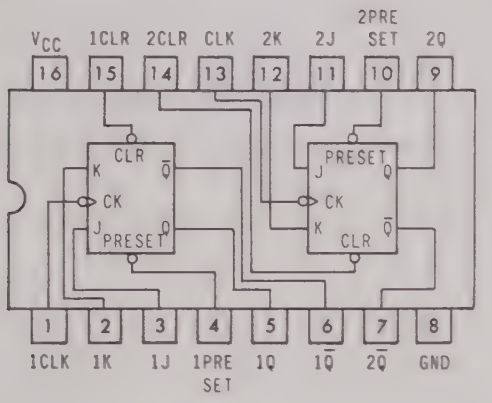
DIGITAL ICs



(TOP VIEW)
SN74LS00N

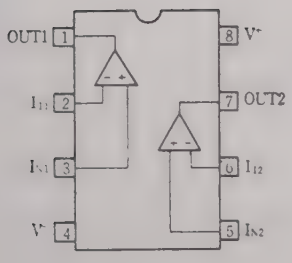


(TOP VIEW)
SN74LS74N

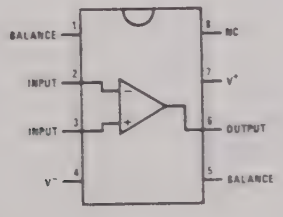


(TOP VIEW)
SN74LS112N

ANALOG ICs

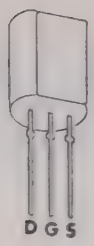


(TOP VIEW)
μPC4558C



(TOP VIEW)
LF13741N
TL081CP

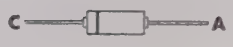
FET



2SK107-3
2SK117-BL

DIODE

GHV-06SSN
ERB26-20



1S1588

1SS83 HZ2B RD5.6JB
1SS86 HZ3C RD13JB
HZ36L

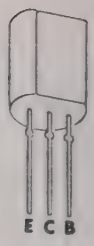
1G4B42

LED

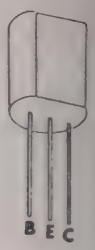
TLG-105

TLR102KW

TRANSISTOR



2SA844-D
2SC1907

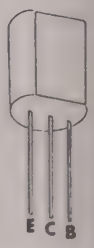


2SC2570

2SA1144-O
2SB648A
2SC1846-R
2SC2371-L
2SC2704-O
2SD668A

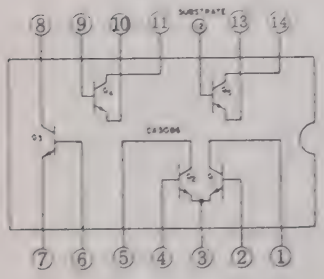
2SA1206-L

2SB834-Y
2SB861-C
2SD880-Y



2SA838-B
2SA1013-Y
2SC945-Q
2SC1843E

TRANSISTOR ARRAY



(TOP VIEW)
CA3086

		PAGE
VERTICAL AMPLIFIER	◇1	 87
TRIG & SWEEP GENERATOR	◇2	 89
CRT CIRCUIT & POWER SUPPLY	◇3	 91
STORAGE CIRCUIT	◇4	 93

NOTES

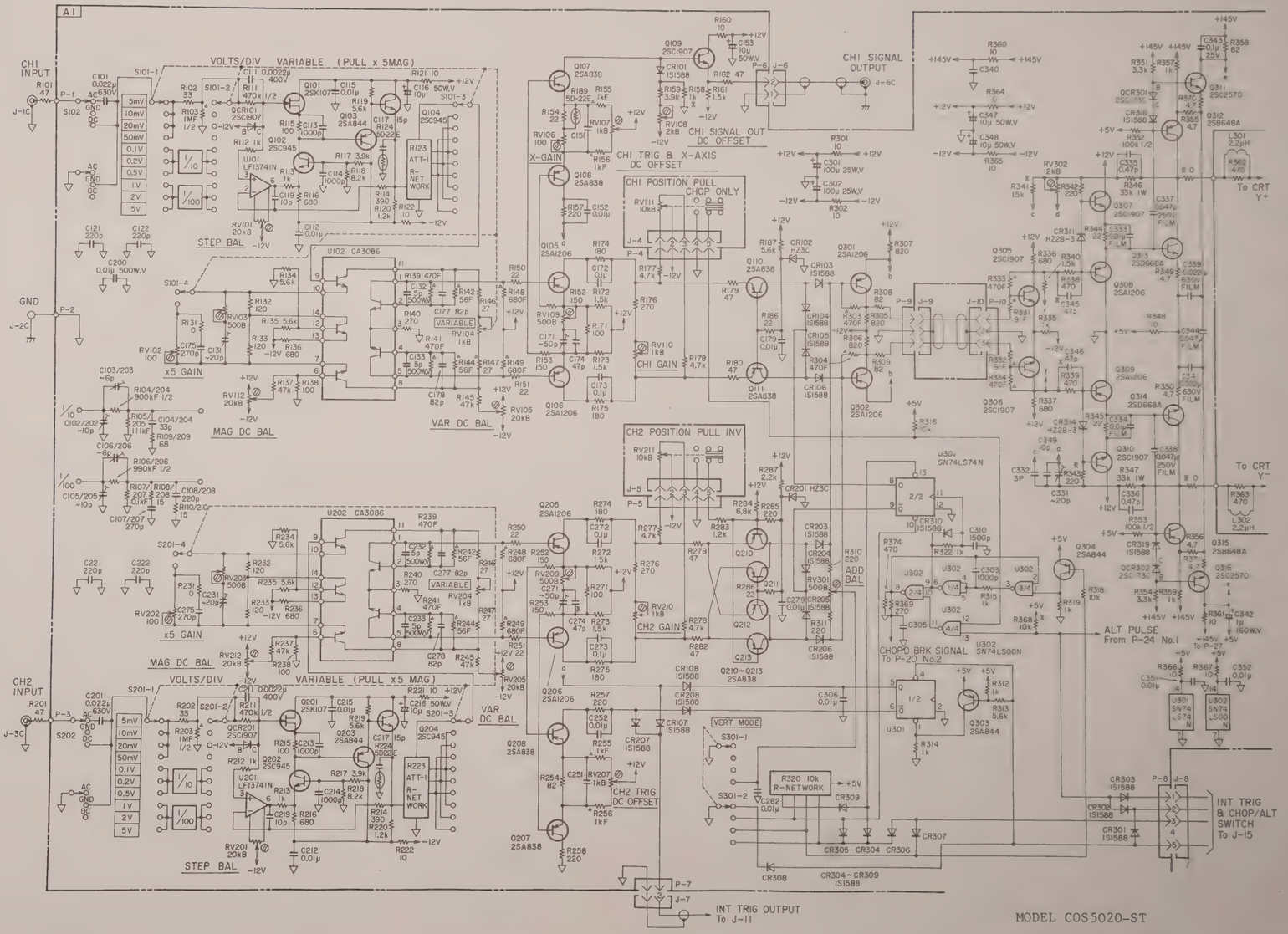
Diodes, transistors and ICs of type numbers different from those indicated but of equivalent characteristics may be used.
Unless otherwise indicated, resistance is given in ohms, 1/4W, 5%, carbon film and capacitor is given in farads.

* Optimum value selected at factory. Average value shown.

(Parts may be omitted.)

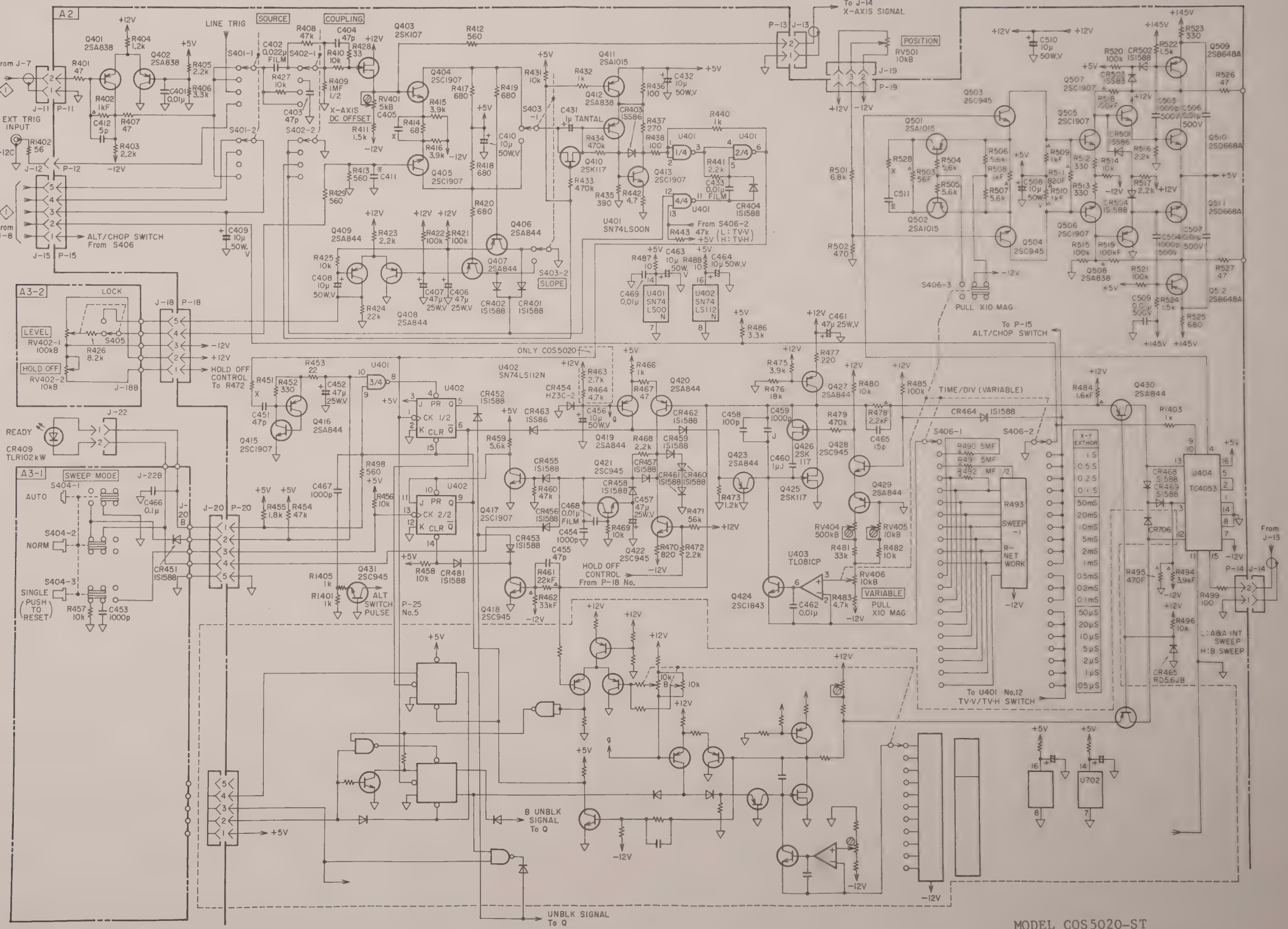
△ Metal film resistor.

⊘ Screwdriver adjustment.



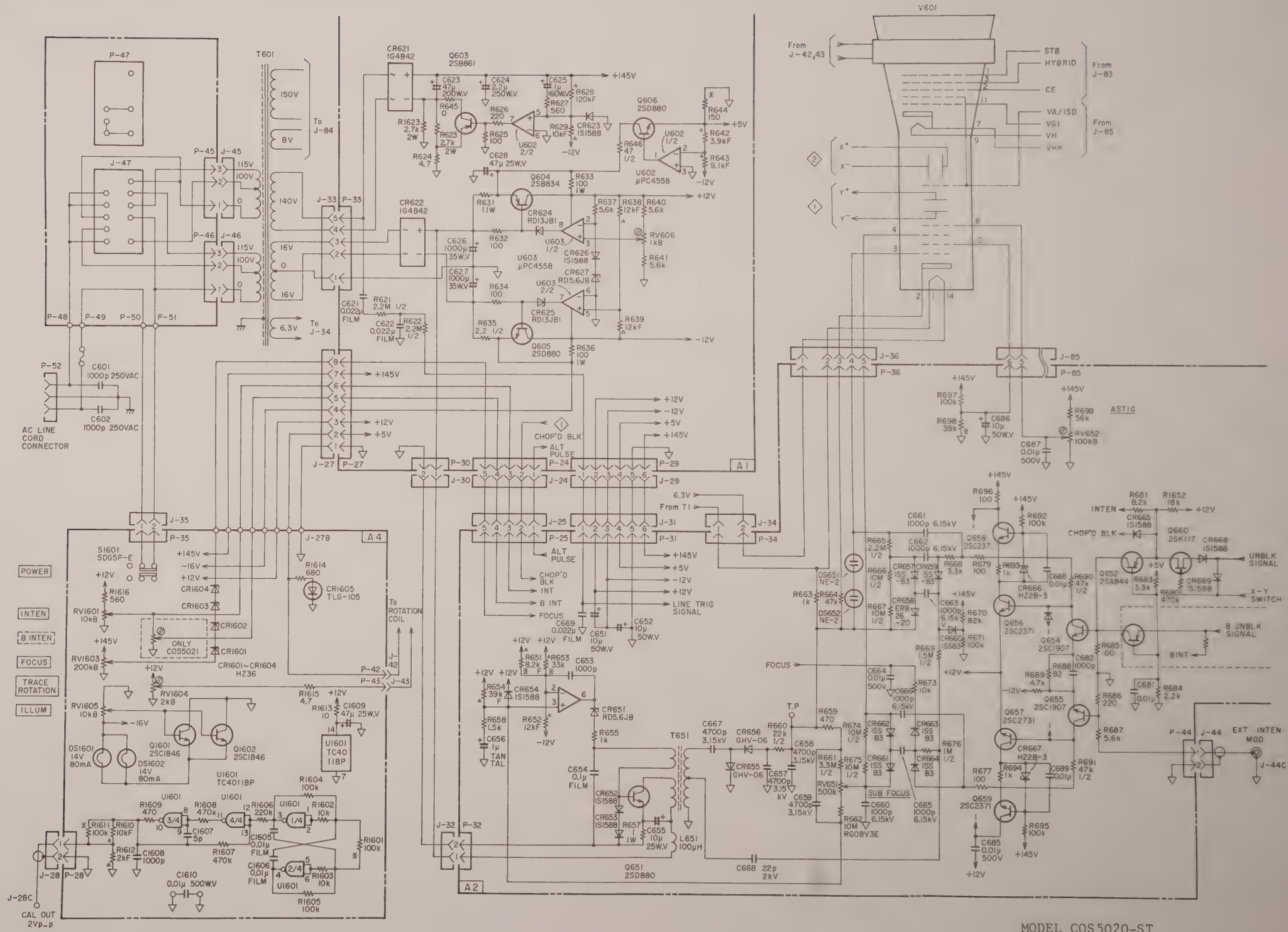
MODEL COS5020-ST

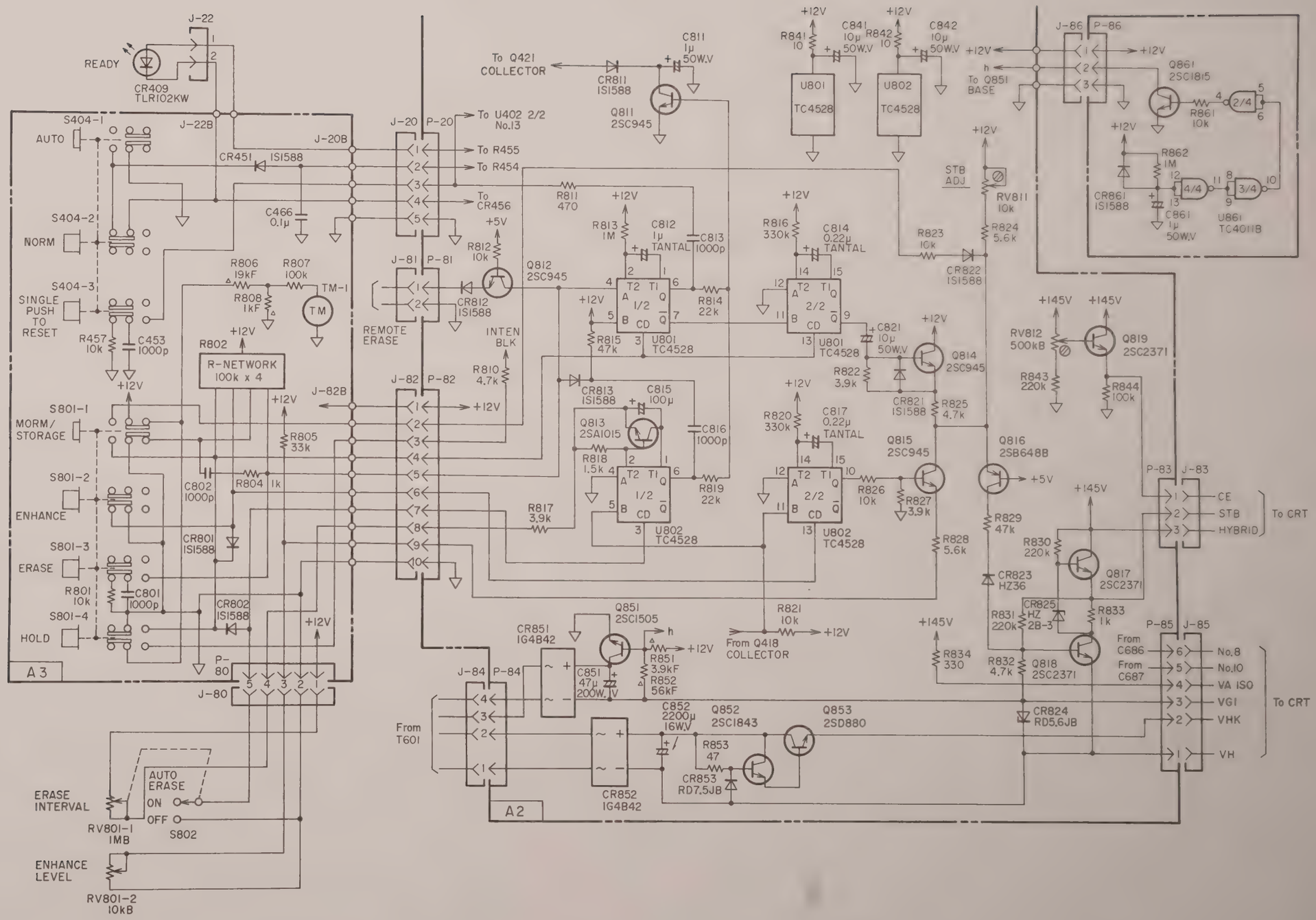
VERTICAL AMPLIFIER ◇1



MODEL COS5020-ST

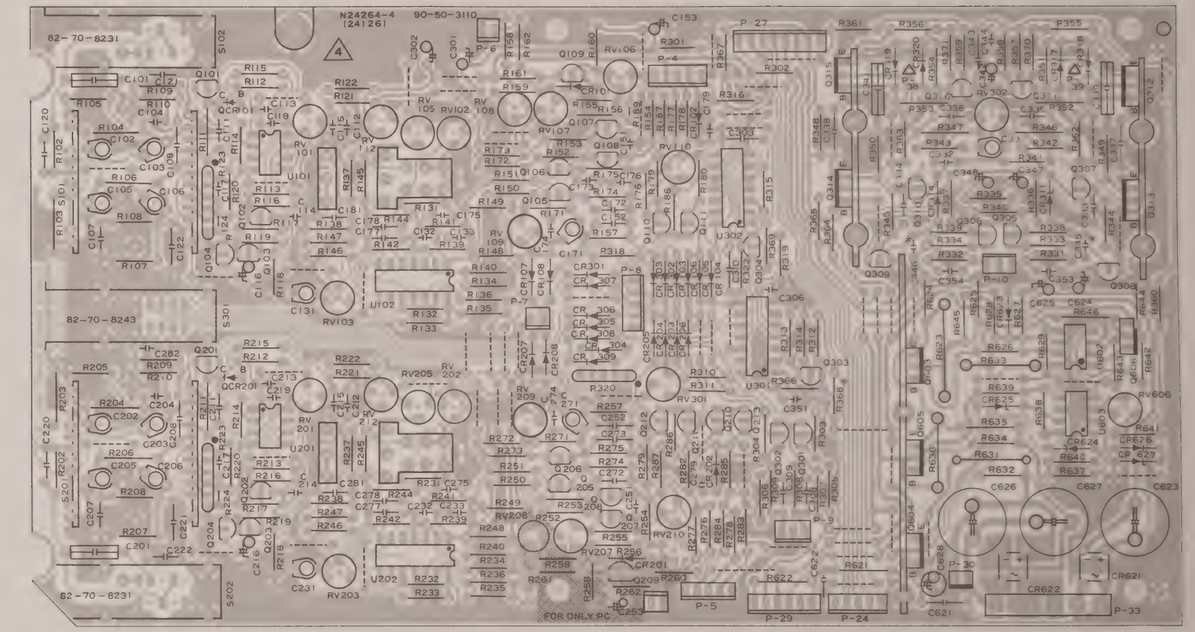
TRIG & SWEEP GENERATOR


MODEL COS5020-ST
CRT CIRCUIT & POWER SUPPLY
3



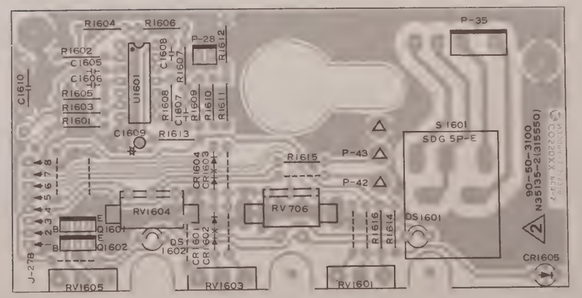
MODEL COS5020-ST

STORAGE CIRCUIT



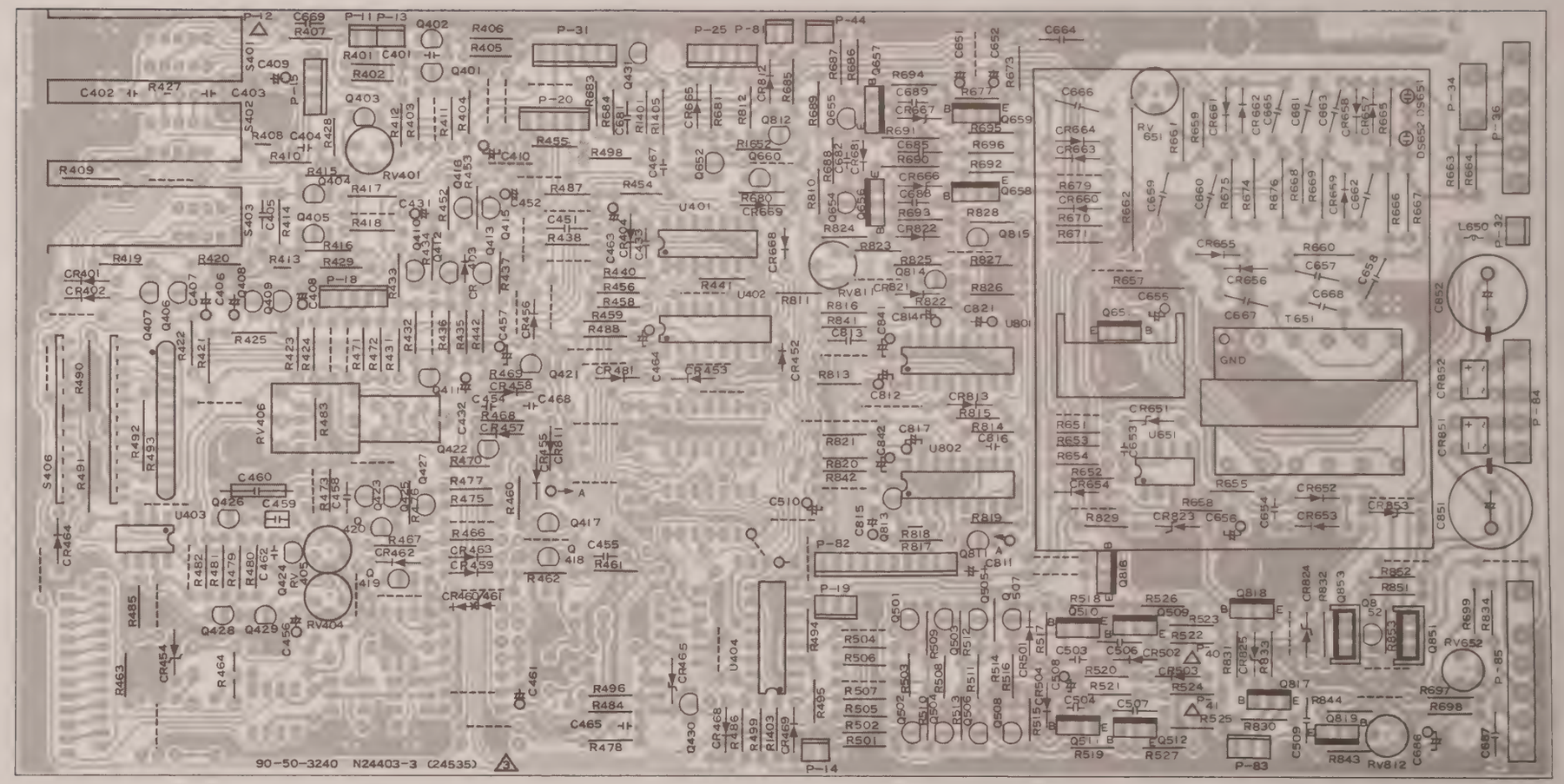
A1 VERT AMP & POWER SUPPLY Parts Location Diagram

(Parts side view)



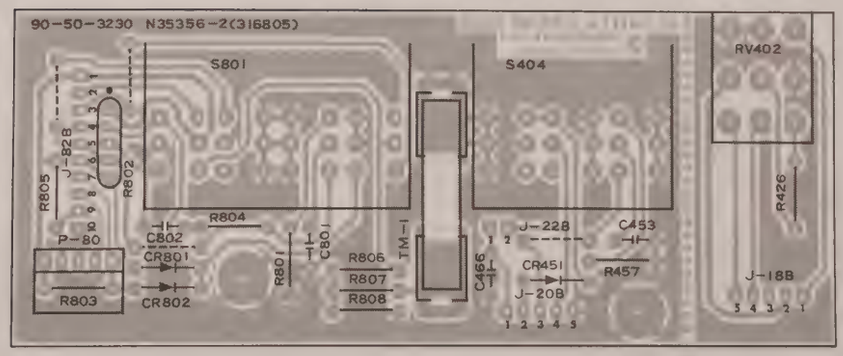
CAL & CRT CONTROL Parts Location Diagram

(Parts side view)



(Parts side view)

A2 SWEEP & H.V. Parts Location Diagram



A3 SWEEP & STRAGE MODE Parts Location Diagram

(Parts side view)

ABBREVIATIONS

CER:	CERAMIC
C FILM:	CARBON FILM
C COMP:	CARBON COMPOSITION
CRT:	CATHODE RAY TUBE
ELECT:	ELECTROLYTIC
FET:	FIELD EFFECT TRANSISTOR
FXD:	FIXED
LED:	LIGHT EMITTING DIODE
M FILM:	METAL FILM
M GLAZE:	METAL GLAZE
M OX:	METAL OXIDE
M PLSTC FILM:	METALLIZED PLASTIC FILM
PLSTC FILM:	PLASTIC FILM
Si:	SILICON
TANT ELECT:	TANTALUM ELECTROLYTIC
VAR:	VARIABLE
WW:	WIREWOUND
*:	OPTIMUM VALUE SELECTED AT FACTORY. AVERAGE VALUE SHOWN.(PART MAY BE OMITTED.)

REFERENCE DESIGNATOR	KIKUSUI PARTS NO.	DESCRIPTION COS5020-ST
A ASSEMBLY		
A1 ASSEMBLY		
C101	50-96-3590	FXD PLSTC FILM 0.022UF 20% 630V
C102	57-10-1191	VAR CER 3-10PF
C103	57-10-1181	VAR CER 3-6PF
C104	52-06-2165	FXD CER 33PF 10% 500V TYPE1
C105	57-10-1191	VAR CER 3-10PF
C106	57-10-1181	VAR CER 3-6PF
C107	52-06-2274	FXD CER 270P 10% 50V TYPE1
C108	52-06-2274	FXD CER 270P 10% 50V TYPE1
C111	50-87-0510	FXD PLSTC FILM 2200PF 20% 400V
C112	52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2
C113	52-01-3345	FXD CER 1000PF 10% 500V TYPE2
C114	52-01-3345	FXD CER 1000PF 10% 500V TYPE2
C115	52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2
C116	54-00-0311	FXD ELECT 10UF 50V
C117	52-06-2125	FXD CER 15PF 10% 500V TYPE1
C119	52-06-2102	FXD CER 10P 10% 50V TYPE1
C121	52-06-2265	FXD CER 220PF 10% 50V TYPE1
C122	52-06-2265	FXD CER 220PF 10% 50V TYPE1
C131	57-10-1203	VAR CER 5-20PF
C132	52-06-3051	FXD CER 5PF 10% 500V TYPE1
C133	52-06-3051	FXD CER 5PF 10% 500V TYPE1
C152	52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2
C153	54-00-0311	FXD ELECT 10UF 50V
C171	57-10-1223	VAR CER 8-50PF
C172	52-05-1498	FXD CER 0.1UF +80-20% 25V TYPE2
C173	52-05-1498	FXD CER 0.1UF +80-20% 25V TYPE2
C174	52-06-2184	FXD CER 47PF 10% 50V TYPE1
C175	52-06-2274	FXD CER 270P 10% 50V TYPE1
C177	52-06-2215	FXD CER 82PF 10% 500V TYPE1
C178	52-06-2215	FXD CER 82PF 10% 500V TYPE1
C179	52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2
C200	52-03-3469	FXD CER 0.01UF +100-0% 500V TYPE2
C201	50-96-3590	FXD PLSTC FILM 0.022UF 20% 630V
C202	57-10-1191	VAR CER 3-10PF
C203	57-10-1181	VAR CER 3-6PF
C204	52-06-2165	FXD CER 33PF 10% 500V TYPE1
C205	57-10-1191	VAR CER 3-10PF
C206	57-10-1181	VAR CER 3-6PF
C207	52-06-2274	FXD CER 270P 10% 50V TYPE1
C208	52-06-2274	FXD CER 270P 10% 50V TYPE1
C211	50-87-0510	FXD PLSTC FILM 2200PF 20% 400V
C212	52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2
C213	52-01-3345	FXD CER 1000PF 10% 500V TYPE2
C214	52-01-3345	FXD CER 1000PF 10% 500V TYPE2
C215	52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2
C216	54-00-0311	FXD ELECT 10UF 50V

REFERENCE DESIGNATOR		KIKUSUI PARTS NO.	DESCRIPTION COS5020-ST		
C217		52-06-2125	FXD CER 15PF 10% 500V TYPE1		
C219		52-06-2102	FXD CER 10P 10% 50V TYPE1		
C221		52-06-2265	FXD CER 220PF 10% 50V TYPE1		
C222		52-06-2265	FXD CER 220PF 10% 50V TYPE1		
C231		57-10-1203	VAR CER 5-20PF		
C232		52-06-3051	FXD CER 5PF 10% 500V TYPE1		
C233		52-06-3051	FXD CER 5PF 10% 500V TYPE1		
C252		52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2		
C271		57-10-1223	VAR CER 8-50PF		
C272		52-05-1498	FXD CER 0.1UF +80-20% 25V TYPE2		
C273		52-05-1498	FXD CER 0.1UF +80-20% 25V TYPE2		
C274		52-06-2184	FXD CER 47PF 10% 50V TYPE1		
C275		52-06-2274	FXD CER 270P 10% 50V TYPE1		
C277		52-06-2215	FXD CER 82PF 10% 500V TYPE1		
C278		52-06-2215	FXD CER 82PF 10% 500V TYPE1		
C279		52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2		
C282		52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2		
C301		54-00-0121	FXD ELECT 100UF 25V		
C302		54-00-0121	FXD ELECT 100UF 25V		
C303		52-01-3345	FXD CER 1000PF 10% 500V TYPE2		
C306		52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2		
C310		52-01-3365	FXD CER 1500PF 10% 50V TYPE2		
C331		57-10-1203	VAR CER 5-20PF		
C332		52-06-2030	FXD CER 3P 10% 50V TYPE1		
C333		50-45-0500	FXD PLSTC FILM 0.01MF 5% 50V		
C334		50-45-0500	FXD PLSTC FILM 0.01MF 5% 50V		
C335		52-96-1140	FXD COMP 0.68PF 10% 500V		
C336		52-96-1140	FXD COMP 0.68PF 10% 500V		
C337		50-77-3500	FXD PLSTC FILM 0.047UF 20% 250V		
C338		50-77-3500	FXD PLSTC FILM 0.047UF 20% 250V		
C339		50-96-3590	FXD PLSTC FILM 0.022UF 20% 630V		
C341		50-96-3590	FXD PLSTC FILM 0.022UF 20% 630V		
C342		54-60-1550	FXD ELECT 1UF 160V		
C343		52-05-1498	FXD CER 0.1UF +80-20% 25V TYPE2		
C344		50-67-0050	FXD PLSTC FILM 0.047UF 10% 100V		
C345	*	52-06-2184	FXD CER 47PF 10% 50V TYPE1		
C346	*	52-06-2184	FXD CER 47PF 10% 50V TYPE1		
C347		54-00-0311	FXD ELECT 10UF 50V		
C348		54-00-0311	FXD ELECT 10UF 50V		
C349		52-06-2102	FXD CER 10P 10% 50V TYPE1		
C351		52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2		
C352		52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2		
C621		50-67-0040	FXD PLSTC FILM 0.022UF 10% 100V		
C622		50-67-0040	FXD PLSTC FILM 0.022UF 10% 100V		
C623		54-60-1730	FXD ELECT 47UF 200V		
C624		54-70-1020	FXD ELECT 2.2UF 250V		
C625		54-60-1550	FXD ELECT 1UF 160V		
C626		54-30-1830	FXD ELECT 1000UF 25V		
C627		54-30-1830	FXD ELECT 1000UF 25V		
C628		54-00-0114	FXD ELECT 47UF 25V		
CR101		32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR102		32-92-0033	ZENER VZ 3.2 - 3.4V	HITACHI	HZ3C-2
CR103		32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588

REFERENCE DESIGNATOR	KIKUSUI PARTS NO.	DESCRIPTION COS5020-ST		
CR104	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR105	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR106	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR107	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR108	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR201	40-27-0000	JUMPER PARTS		
CR202	32-92-0033	ZENER VZ 3.2 - 3.4V	HITACHI	HZ3C-2
CR203	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR204	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR205	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR206	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR207	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR208	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR301	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR302	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR303	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR304	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR305	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR306	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR307	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR308	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR309	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR310	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR311	32-92-0022	ZENER VZ 2.1 - 2.3V	HITACHI	HZ2B-3
CR314	32-92-0022	ZENER VZ 2.1 - 2.3V	HITACHI	HZ2B-3
CR318	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR319	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR621	32-90-2110	DIODE BRIGE VRM 400V IO 1A	TOSHIBA	1G4B42
CR622	32-90-2110	DIODE BRIGE VRM 400V IO 1A	TOSHIBA	1G4B42
CR623	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR624	32-92-0130	ZENER VZ 12.4-13.1V P 0.4W	NEC	RD13JB1
CR625	32-92-0130	ZENER VZ 12.4-13.1V P 0.4W	NEC	RD13JB1
CR626	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR627	32-92-0056	ZENER VZ 5.5 - 5.8V P 0.4W	NEC	RD5.6JB2
L301	67-10-0880	INDUCTOR 2.2UH 20%		
L302	67-10-0880	INDUCTOR 2.2UH 20%		
Q101	31-20-1073	FET IDSS 4.5-7.7MA	SONY	2SK107-3
Q102	30-30-9451	TR SI NPN	NEC	2SC945-Q
Q103	30-10-8441	TR SI PNP	HITACHI	2SA844-D
Q104	30-30-9451	TR SI NPN	NEC	2SC945-Q
Q105	30-11-2061	TR SI PNP	NEC	2SA1206-L
Q106	30-11-2061	TR SI PNP	NEC	2SA1206-L
Q107	30-10-8381	TR SI PNP	MATSUSITA	2SA838-B
Q108	30-10-8381	TR SI PNP	MATSUSITA	2SA838-B
Q109	30-31-9071	TR SI NPN	HITACHI	2SC1907
Q110	30-10-8381	TR SI PNP	MATSUSITA	2SA838-B
Q111	30-10-8381	TR SI PNP	MATSUSITA	2SA838-B
Q201	31-20-1073	FET IDSS 4.5-7.7MA	SONY	2SK107-3
Q202	30-30-9451	TR SI NPN	NEC	2SC945-Q
Q203	30-10-8441	TR SI PNP	HITACHI	2SA844-D
Q204	30-30-9451	TR SI NPN	NEC	2SC945-Q
Q205	30-11-2061	TR SI PNP	NEC	2SA1206-L

REFERENCE DESIGNATOR	KIKUSUI PARTS NO.	DESCRIPTION	COS5020-ST	
Q206	30-11-2061	TR SI PNP	NEC	2SA1206-L
Q207	30-10-8381	TR SI PNP	MATSUSITA	2SA838-B
Q208	30-10-8381	TR SI PNP	MATSUSITA	2SA838-B
Q210	30-10-8381	TR SI PNP	MATSUSITA	2SA838-B
Q211	30-10-8381	TR SI PNP	MATSUSITA	2SA838-B
Q212	30-10-8381	TR SI PNP	MATSUSITA	2SA838-B
Q213	30-10-8381	TR SI PNP	MATSUSITA	2SA838-B
Q301	30-11-2061	TR SI PNP	NEC	2SA1206-L
Q302	30-11-2061	TR SI PNP	NEC	2SA1206-L
Q303	30-10-8441	TR SI PNP	HITACHI	2SA844-D
Q304	30-10-8441	TR SI PNP	HITACHI	2SA844-D
Q305	30-31-9071	TR SI NPN	HITACHI	2SC1907
Q306	30-31-9071	TR SI NPN	HITACHI	2SC1907
Q307	30-31-9071	TR SI NPN	HITACHI	2SC1907
Q308	30-11-2061	TR SI PNP	NEC	2SA1206-L
Q309	30-11-2061	TR SI PNP	NEC	2SA1206-L
Q310	30-31-9071	TR SI NPN	HITACHI	2SC1907
Q311	30-32-7531	TR SI NPN	TOSHIBA	2SC2753
Q312	30-20-6481	TR SI PNP	HITACHI	2SB648A
Q313	30-40-6681	TR SI NPN	HITACHI	2SD668A-C
Q314	30-40-6681	TR SI NPN	HITACHI	2SD668A-C
Q315	30-20-6481	TR SI PNP	HITACHI	2SB648A
Q316	30-32-7531	TR SI NPN	TOSHIBA	2SC2753
Q603	30-10-9580	TR SI PNP	KIKUSUI	S8309591
Q604	30-20-8341	TR SI PNP	TOSHIBA	2SB834-Y
Q605	30-40-8802	TR SI NPN	TOSHIBA	2SD880-Y
Q606	30-40-8802	TR SI NPN	TOSHIBA	2SD880-Y
QCR101	30-31-9071	TR SI NPN	HITACHI	2SC1907
QCR201	30-31-9071	TR SI NPN	HITACHI	2SC1907
QCR301	30-31-7301	TR SI NPN	NEC	2SC1730-L
QCR302	30-31-7301	TR SI NPN	NEC	2SC1730-L
R102	40-27-0332	FXD C FILM	33 OHM 5% 1/4W	
R103	42-33-0420	FXD M FILM	1M OHM 1% 1/2W	
R104	42-33-0390	FXD M FILM	900K OHM 0.5% 1/2W	
R105	42-82-4111	FXD M FILM	111K OHM 0.5% 1/4W	
R106	42-33-0400	FXD M FILM	990K OHM 0.5% 1/2W	
R107	42-82-3101	FXD M FILM	10.1K OHM 0.5% 1/4W	
R108	40-27-0152	FXD C FILM	15 OHM 5% 1/4W	
R109	40-27-0682	FXD C FILM	68 OHM 5% 1/4W	
R110	40-27-0152	FXD C FILM	15 OHM 5% 1/4W	
R111	40-37-4471	FXD C FILM	470K OHM 5% 1/2W	
R112	40-27-2102	FXD C FILM	1K OHM 5% 1/4W	
R113	40-27-2102	FXD C FILM	1K OHM 5% 1/4W	
R114	40-27-1392	FXD C FILM	390 OHM 5% 1/4W	
R115	40-27-1102	FXD C FILM	100 OHM 5% 1/4W	
R116	40-27-1682	FXD C FILM	680 OHM 5% 1/4W	
R117	40-27-2392	FXD C FILM	3.9K OHM 5% 1/4W	
R118	40-27-2822	FXD C FILM	8.2K OHM 5% 1/4W	
R119	40-27-2562	FXD C FILM	5.6K OHM 5% 1/4W	
R120	40-27-2122	FXD C FILM	1.2K OHM 5% 1/4W	
R121	40-27-0102	FXD C FILM	10 OHM 5% 1/4W	
R122	40-27-0102	FXD C FILM	10 OHM 5% 1/4W	

REFERENCE DESIGNATOR		KIKUSUI PARTS NO.	DESCRIPTION	COS5020-ST
R123		44-04-0000	FXD M GLAZE R-NETWORK	KIKUSUI S8109001
R124		38-00-0070	THERMISTOR 200 OHM	
R131		40-27-0000	JUMPER PARTS	
R132		40-27-1122	FXD C FILM 120 OHM 5% 1/4W	
R133		40-27-1122	FXD C FILM 120 OHM 5% 1/4W	
R134		40-27-2562	FXD C FILM 5.6K OHM 5% 1/4W	
R135		40-27-2562	FXD C FILM 5.6K OHM 5% 1/4W	
R136		40-27-1682	FXD C FILM 680 OHM 5% 1/4W	
R137		40-27-3472	FXD C FILM 47K OHM 5% 1/4W	
R138		40-27-1102	FXD C FILM 100 OHM 5% 1/4W	
R139		42-83-1470	FXD M FILM 470 OHM 1% 1/4W	
R140		40-27-1272	FXD C FILM 270 OHM 5% 1/4W	
R141		42-83-1470	FXD M FILM 470 OHM 1% 1/4W	
R142		42-83-0560	FXD M FILM 56 OHM 1% 1/4W	
R144		42-83-0560	FXD M FILM 56 OHM 1% 1/4W	
R145		40-27-3472	FXD C FILM 47K OHM 5% 1/4W	
R146		40-27-0272	FXD C FILM 27 OHM 5% 1/4W	
R147		40-27-0272	FXD C FILM 27 OHM 5% 1/4W	
R148		42-83-1680	FXD M FILM 680 OHM 1% 1/4W	
R149		42-83-1680	FXD M FILM 680 OHM 1% 1/4W	
R150		40-27-0222	FXD C FILM 22 OHM 5% 1/4W	
R151		40-27-0222	FXD C FILM 22 OHM 5% 1/4W	
R152		40-27-1152	FXD C FILM 150 OHM 5% 1/4W	
R153		40-27-1152	FXD C FILM 150 OHM 5% 1/4W	
R154		40-27-0222	FXD C FILM 22 OHM 5% 1/4W	
R155		42-83-2100	FXD M FILM 1K OHM 1% 1/4W	
R156		42-83-2100	FXD M FILM 1K OHM 1% 1/4W	
R157		40-27-1222	FXD C FILM 220 OHM 5% 1/4W	
R158	*	40-27-2102	FXD C FILM 1K OHM 5% 1/4W	
R159		40-27-2392	FXD C FILM 3.9K OHM 5% 1/4W	
R160		40-27-0102	FXD C FILM 10 OHM 5% 1/4W	
R161		40-27-2152	FXD C FILM 1.5K OHM 5% 1/4W	
R162		40-27-0472	FXD C FILM 47 OHM 5% 1/4W	
R171		40-27-1102	FXD C FILM 100 OHM 5% 1/4W	
R172		40-27-2152	FXD C FILM 1.5K OHM 5% 1/4W	
R173		40-27-2152	FXD C FILM 1.5K OHM 5% 1/4W	
R174		40-27-1182	FXD C FILM 180 OHM 5% 1/4W	
R175		40-27-1182	FXD C FILM 180 OHM 5% 1/4W	
R176		40-27-1272	FXD C FILM 270 OHM 5% 1/4W	
R177		40-27-2472	FXD C FILM 4.7K OHM 5% 1/4W	
R178		40-27-2472	FXD C FILM 4.7K OHM 5% 1/4W	
R179		40-27-0472	FXD C FILM 47 OHM 5% 1/4W	
R180		40-27-0472	FXD C FILM 47 OHM 5% 1/4W	
R186		40-27-0222	FXD C FILM 22 OHM 5% 1/4W	
R187		40-27-2562	FXD C FILM 5.6K OHM 5% 1/4W	
R189		38-00-0070	THERMISTOR 200 OHM	
R202		40-27-0332	FXD C FILM 33 OHM 5% 1/4W	
R203		42-33-0420	FXD M FILM 1M OHM 1% 1/2W	
R204		42-33-0390	FXD M FILM 900K OHM 0.5% 1/2W	
R205		42-82-4111	FXD M FILM 111K OHM 0.5% 1/4W	
R206		42-33-0400	FXD M FILM 990K OHM 0.5% 1/2W	
R207		42-82-3101	FXD M FILM 10.1K OHM 0.5% 1/4W	
R208		40-27-0152	FXD C FILM 15 OHM 5% 1/4W	
R209		40-27-0682	FXD C FILM 68 OHM 5% 1/4W	

REFERENCE DESIGNATOR	KIKUSUI PARTS NO.	DESCRIPTION	COS5020-ST
R210	40-27-0152	FXD C FILM 15 OHM 5% 1/4W	
R211	40-37-4471	FXD C FILM 470K OHM 5% 1/2W	
R212	40-27-2102	FXD C FILM 1K OHM 5% 1/4W	
R213	40-27-2102	FXD C FILM 1K OHM 5% 1/4W	
R214	40-27-1392	FXD C FILM 390 OHM 5% 1/4W	
R215	40-27-1102	FXD C FILM 100 OHM 5% 1/4W	
R216	40-27-1682	FXD C FILM 680 OHM 5% 1/4W	
R217	40-27-2392	FXD C FILM 3.9K OHM 5% 1/4W	
R218	40-27-2822	FXD C FILM 8.2K OHM 5% 1/4W	
R219	40-27-2562	FXD C FILM 5.6K OHM 5% 1/4W	
R220	40-27-2122	FXD C FILM 1.2K OHM 5% 1/4W	
R221	40-27-0102	FXD C FILM 10 OHM 5% 1/4W	
R222	40-27-0102	FXD C FILM 10 OHM 5% 1/4W	
R223	44-04-0000	FXD M GLAZE R-NETWORK	KIKUSUI S8109001
R224	38-00-0070	THERMISTOR 200 OHM	
R231	40-27-0000	JUMPER PARTS	
R232	40-27-1122	FXD C FILM 120 OHM 5% 1/4W	
R233	40-27-1122	FXD C FILM 120 OHM 5% 1/4W	
R234	40-27-2562	FXD C FILM 5.6K OHM 5% 1/4W	
R235	40-27-2562	FXD C FILM 5.6K OHM 5% 1/4W	
R236	40-27-1682	FXD C FILM 680 OHM 5% 1/4W	
R237	40-27-3472	FXD C FILM 47K OHM 5% 1/4W	
R238	40-27-1102	FXD C FILM 100 OHM 5% 1/4W	
R239	42-83-1470	FXD M FILM 470 OHM 1% 1/4W	
R240	40-27-1272	FXD C FILM 270 OHM 5% 1/4W	
R241	42-83-1470	FXD M FILM 470 OHM 1% 1/4W	
R242	42-83-0560	FXD M FILM 56 OHM 1% 1/4W	
R244	42-83-0560	FXD M FILM 56 OHM 1% 1/4W	
R245	40-27-3472	FXD C FILM 47K OHM 5% 1/4W	
R246	40-27-0272	FXD C FILM 27 OHM 5% 1/4W	
R247	40-27-0272	FXD C FILM 27 OHM 5% 1/4W	
R248	42-83-1680	FXD M FILM 680 OHM 1% 1/4W	
R249	42-83-1680	FXD M FILM 680 OHM 1% 1/4W	
R250	40-27-0222	FXD C FILM 22 OHM 5% 1/4W	
R251	40-27-0222	FXD C FILM 22 OHM 5% 1/4W	
R252	40-27-1152	FXD C FILM 150 OHM 5% 1/4W	
R253	40-27-1152	FXD C FILM 150 OHM 5% 1/4W	
R254	40-27-0822	FXD C FILM 82 OHM 5% 1/4W	
R255	42-83-2100	FXD M FILM 1K OHM 1% 1/4W	
R256	42-83-2100	FXD M FILM 1K OHM 1% 1/4W	
R257	40-27-1222	FXD C FILM 220 OHM 5% 1/4W	
R258	40-27-1222	FXD C FILM 220 OHM 5% 1/4W	
R271	40-27-1102	FXD C FILM 100 OHM 5% 1/4W	
R272	40-27-2152	FXD C FILM 1.5K OHM 5% 1/4W	
R273	40-27-2152	FXD C FILM 1.5K OHM 5% 1/4W	
R274	40-27-1182	FXD C FILM 180 OHM 5% 1/4W	
R275	40-27-1182	FXD C FILM 180 OHM 5% 1/4W	
R276	40-27-1272	FXD C FILM 270 OHM 5% 1/4W	
R277	40-27-2472	FXD C FILM 4.7K OHM 5% 1/4W	
R278	40-27-2472	FXD C FILM 4.7K OHM 5% 1/4W	
R279	40-27-0472	FXD C FILM 47 OHM 5% 1/4W	
R282	40-27-0472	FXD C FILM 47 OHM 5% 1/4W	
R283	40-27-2122	FXD C FILM 1.2K OHM 5% 1/4W	
R284	40-27-2682	FXD C FILM 6.8K OHM 5% 1/4W	

REFERENCE DESIGNATOR		KIKUSUI PARTS NO.	DESCRIPTION	COS5020-ST
R285		40-27-1222	FXD C FILM 220	OHM 5% 1/4W
R286		40-27-0222	FXD C FILM 22	OHM 5% 1/4W
R287		40-27-2222	FXD C FILM 2.2K	OHM 5% 1/4W
R301		40-27-0102	FXD C FILM 10	OHM 5% 1/4W
R302		40-27-0102	FXD C FILM 10	OHM 5% 1/4W
R303		42-83-1470	FXD M FILM 470	OHM 1% 1/4W
R304		42-83-1470	FXD M FILM 470	OHM 1% 1/4W
R305		40-27-1822	FXD C FILM 820	OHM 5% 1/4W
R306		40-27-1822	FXD C FILM 820	OHM 5% 1/4W
R307		40-27-1822	FXD C FILM 820	OHM 5% 1/4W
R308		40-27-0822	FXD C FILM 82	OHM 5% 1/4W
R309		40-27-0822	FXD C FILM 82	OHM 5% 1/4W
R310		40-27-1222	FXD C FILM 220	OHM 5% 1/4W
R311		40-27-1222	FXD C FILM 220	OHM 5% 1/4W
R312		40-27-2102	FXD C FILM 1K	OHM 5% 1/4W
R313		40-27-2562	FXD C FILM 5.6K	OHM 5% 1/4W
R314		40-27-2102	FXD C FILM 1K	OHM 5% 1/4W
R315		40-27-2102	FXD C FILM 1K	OHM 5% 1/4W
R316		40-27-3102	FXD C FILM 10K	OHM 5% 1/4W
R318		40-27-3102	FXD C FILM 10K	OHM 5% 1/4W
R319		40-27-2102	FXD C FILM 1K	OHM 5% 1/4W
R320		44-07-0020	FXD M GLAZE RESISTOR NETWORKS	10K OHM X4
R322		40-27-2102	FXD C FILM 1K	OHM 5% 1/4W
R331		42-83-0910	FXD M FILM 91	OHM 1% 1/4W
R332		42-83-0910	FXD M FILM 91	OHM 1% 1/4W
R333		42-83-1470	FXD M FILM 470	OHM 1% 1/4W
R334		42-83-1470	FXD M FILM 470	OHM 1% 1/4W
R335		40-27-2102	FXD C FILM 1K	OHM 5% 1/4W
R336		40-27-1682	FXD C FILM 680	OHM 5% 1/4W
R337		40-27-1682	FXD C FILM 680	OHM 5% 1/4W
R338		40-27-1472	FXD C FILM 470	OHM 5% 1/4W
R339		40-27-1472	FXD C FILM 470	OHM 5% 1/4W
R340		40-27-2152	FXD C FILM 1.5K	OHM 5% 1/4W
R341	*	40-27-3152	FXD C FILM 15K	OHM 5% 1/4W
R342		40-27-1222	FXD C FILM 220	OHM 5% 1/4W
R343		40-27-1222	FXD C FILM 220	OHM 5% 1/4W
R344		40-27-0222	FXD C FILM 22	OHM 5% 1/4W
R345		40-27-0222	FXD C FILM 22	OHM 5% 1/4W
R346		44-91-3330	FXD M OXIDE 33K	OHM 5% 1W
R347		44-91-3330	FXD M OXIDE 33K	OHM 5% 1W
R348		40-27-0102	FXD C FILM 10	OHM 5% 1/4W
R349		40-27-8472	FXD C FILM 4.7	OHM 5% 1/4W
R350		40-27-8472	FXD C FILM 4.7	OHM 5% 1/4W
R351		40-27-2332	FXD C FILM 3.3K	OHM 5% 1/4W
R352		40-37-4101	FXD C FILM 100K	OHM 5% 1/2W
R353		40-37-4101	FXD C FILM 100K	OHM 5% 1/2W
R354		40-27-2332	FXD C FILM 3.3K	OHM 5% 1/4W
R355		40-27-8472	FXD C FILM 4.7	OHM 5% 1/4W
R356		40-27-8472	FXD C FILM 4.7	OHM 5% 1/4W
R357		40-27-2102	FXD C FILM 1K	OHM 5% 1/4W
R358		40-27-0822	FXD C FILM 82	OHM 5% 1/4W
R359		40-27-2102	FXD C FILM 1K	OHM 5% 1/4W
R360		40-27-0102	FXD C FILM 10	OHM 5% 1/4W
R361		40-27-0102	FXD C FILM 10	OHM 5% 1/4W

REFERENCE DESIGNATOR		KIKUSUI PARTS NO.	DESCRIPTION	COS5020-ST
R362		40-27-1472	FXD C FILM 470	OHM 5% 1/4W
R363		40-27-1472	FXD C FILM 470	OHM 5% 1/4W
R364		40-27-0102	FXD C FILM 10	OHM 5% 1/4W
R365		40-27-0102	FXD C FILM 10	OHM 5% 1/4W
R366		40-27-0102	FXD C FILM 10	OHM 5% 1/4W
R367		40-27-0102	FXD C FILM 10	OHM 5% 1/4W
R368	*	40-27-3102	FXD C FILM 10K	OHM 5% 1/4W
R369		40-27-1272	FXD C FILM 270	OHM 5% 1/4W
R370		40-27-8472	FXD C FILM 4.7	OHM 5% 1/4W
R371		40-27-8472	FXD C FILM 4.7	OHM 5% 1/4W
R374		40-27-1472	FXD C FILM 470	OHM 5% 1/4W
R621		40-37-5221	FXD C FILM 2.2M	OHM 5% 1/2W
R622		40-37-5221	FXD C FILM 2.2M	OHM 5% 1/2W
R623		44-92-2270	FXD M OXIDE 2.7K	OHM 5% 2W
R624		40-27-8472	FXD C FILM 4.7	OHM 5% 1/4W
R625		40-27-1102	FXD C FILM 100	OHM 5% 1/4W
R626		40-27-1222	FXD C FILM 220	OHM 5% 1/4W
R627		40-27-1562	FXD C FILM 560	OHM 5% 1/4W
R628		42-83-4120	FXD M FILM 120K	OHM 1% 1/4W
R629		42-83-3100	FXD M FILM 10K	OHM 1% 1/4W
R630		44-92-2270	FXD M OXIDE 2.7K	OHM 5% 2W
R631		44-91-0010	FXD M OXIDE 1	OHM 5% 1W
R632		40-27-1102	FXD C FILM 100	OHM 5% 1/4W
R633		44-91-1100	FXD M OXIDE 100	OHM 5% 1W
R634		40-27-1102	FXD C FILM 100	OHM 5% 1/4W
R635		40-37-8222	FXD C FILM 2.2	OHM 5% 1/2W
R636		44-91-1100	FXD M OXIDE 100	OHM 5% 1W
R637		40-27-2562	FXD C FILM 5.6K	OHM 5% 1/4W
R638		42-83-3120	FXD M FILM 12K	OHM 1% 1/4W
R639		42-83-3120	FXD M FILM 12K	OHM 1% 1/4W
R640		40-27-2562	FXD C FILM 5.6K	OHM 5% 1/4W
R641		40-27-2562	FXD C FILM 5.6K	OHM 5% 1/4W
R642		42-83-2390	FXD M FILM 3.9K	OHM 1% 1/4W
R643		42-83-2910	FXD M FILM 9.1K	OHM 1% 1/4W
R644	*	40-27-1152	FXD C FILM 150	OHM 5% 1/4W
R645		40-27-0000	JUMPER PARTS	
R646		40-37-0471	FXD C FILM 47	OHM 5% 1/2W
RV101		48-33-3200	VAR M FILM 20K	OHM
RV102		48-33-1100	VAR M FILM 100	OHM
RV103		48-33-1500	VAR M FILM 500	OHM
RV105		48-33-3200	VAR M FILM 20K	OHM
RV106		48-33-1100	VAR M FILM 100	OHM
RV107		48-33-2100	VAR M FILM 1K	OHM
RV108		48-33-2200	VAR M FILM 2K	OHM
RV109		48-33-1500	VAR M FILM 500	OHM
RV110		48-33-2100	VAR M FILM 1K	OHM
RV112		48-33-3200	VAR M FILM 20K	OHM
RV201		48-33-3200	VAR M FILM 20K	OHM
RV202		48-33-1100	VAR M FILM 100	OHM
RV203		48-33-1500	VAR M FILM 500	OHM
RV205		48-33-3200	VAR M FILM 20K	OHM
RV207		48-33-2100	VAR M FILM 1K	OHM
RV209		48-33-1500	VAR M FILM 500	OHM

REFERENCE DESIGNATOR		KIKUSUI PARTS NO.	DESCRIPTION	COS5020-ST	
RV210		48-33-2100	VAR M FILM 1K OHM		
RV212		48-33-3200	VAR M FILM 20K OHM		
RV301		48-33-1500	VAR M FILM 500 OHM		
RV302		48-33-2200	VAR M FILM 2K OHM		
RV606		48-33-2100	VAR M FILM 1K OHM		
S101		80-98-0580	SW ROTARY WITH RV VOLT/DIV	ALPS	S21P2YC
S102		82-70-8231	LEVER SWITCH	ALPS	SLR823-1
S201		80-98-0580	SW ROTARY WITH RV VOLT/DIV	ALPS	S21P2YC
S202		82-70-8231	LEVER SWITCH	ALPS	SLR823-1
S301		82-70-8243	LEVER SWITCH	ALPS	SLR824-3
U101		34-00-0121	FET OPE-AMP	N.S	LF13741N
U102		30-90-0141	TRANSISTOR ARRAYS 5 NPN	RCA	CA3086
U201		34-00-0121	FET OPE-AMP	N.S	LF13741N
U202		30-90-0141	TRANSISTOR ARRAYS 5 NPN	RCA	CA3086
U301		35-70-0741	DUAL D F-F EDGE TRIGGER	TEXAS INS.	HD74LS74P
U302		35-70-0001	QUAD 2-INPUT POSI-NAND	TEXAS INS.	SN74LS00N
U602		34-00-0240	DUAL OPE-AMP	NEC	UPC4558C
U603		34-00-0240	DUAL OPE-AMP	NEC	UPC4558C

A2 ASSEMBLY

C401		52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2
C402		50-67-0040	FXD PLSTC FILM 0.022UF 10% 100V
C403		52-06-2184	FXD CER 47PF 10% 50V TYPE1
C404		52-06-2184	FXD CER 47PF 10% 50V TYPE1
C405	*	52-06-2265	FXD CER 220PF 10% 50V TYPE1
C406		54-00-0114	FXD ELECT 47UF 25V
C407		54-00-0114	FXD ELECT 47UF 25V
C408		54-00-0311	FXD ELECT 10UF 50V
C409		54-00-0311	FXD ELECT 10UF 50V
C410		54-00-0311	FXD ELECT 10UF 50V
C431		55-37-2050	FXD TANT ELECT 1UF 35V
C432		54-00-0311	FXD ELECT 10UF 50V
C433		50-67-0030	FXD PLSTC FILM 0.01UF 10% 100V
C451		52-06-2184	FXD CER 47PF 10% 50V TYPE1
C452		54-00-0114	FXD ELECT 47UF 25V
C454		52-01-3345	FXD CER 1000PF 10% 500V TYPE2
C455		52-06-2184	FXD CER 47PF 10% 50V TYPE1
C456		54-00-0311	FXD ELECT 10UF 50V
C457		54-00-0114	FXD ELECT 47UF 25V
C458		52-06-2225	FXD CER 100PF 10% 50V TYPE1
C459		50-65-0530	FXD M PLSTC FILM 1000PF 5% 100V
C460		50-65-0540	FXD M PLSTC FILM 1UF 5% 100V
C461		54-00-0114	FXD ELECT 47UF 25V
C462		52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2
C463		54-00-0311	FXD ELECT 10UF 50V
C464		54-00-0311	FXD ELECT 10UF 50V
C465		52-06-2125	FXD CER 15PF 10% 500V TYPE1
C467		52-01-3345	FXD CER 1000PF 10% 500V TYPE2
C468		50-67-0030	FXD PLSTC FILM 0.01UF 10% 100V

REFERENCE DESIGNATOR	KIKUSUI PARTS NO.	DESCRIPTION COS5020-ST		
C469	52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2		
C503	52-01-3345	FXD CER 1000PF 10% 500V TYPE2		
C504	52-01-3345	FXD CER 1000PF 10% 500V TYPE2		
C506	52-03-3469	FXD CER 0.01UF +100-0% 500V TYPE2		
C507	52-03-3469	FXD CER 0.01UF +100-0% 500V TYPE2		
C508	54-00-0311	FXD ELECT 10UF 50V		
C509	52-03-3469	FXD CER 0.01UF +100-0% 500V TYPE2		
C510	54-00-0311	FXD ELECT 10UF 50V		
C651	54-00-0311	FXD ELECT 10UF 50V		
C652	54-00-0311	FXD ELECT 10UF 50V		
C653	52-01-3345	FXD CER 1000PF 10% 500V TYPE2		
C654	50-67-0050	FXD PLSTC FILM 0.047UF 10% 100V		
C655	54-00-0311	FXD ELECT 10UF 50V		
C656	55-37-2050	FXD TANT ELECT 1UF 35V		
C657	52-98-1000	FXD CER 4700PF +80-20% 3.15KV TYPE1		
C658	52-98-1000	FXD CER 4700PF +80-20% 3.15KV TYPE1		
C659	52-98-1000	FXD CER 4700PF +80-20% 3.15KV TYPE1		
C660	52-98-1010	FXD CER 1000PF +80-20% 6.3KV TYPE1		
C661	52-98-1010	FXD CER 1000PF +80-20% 6.3KV TYPE1		
C662	52-98-1010	FXD CER 1000PF +80-20% 6.3KV TYPE1		
C663	52-98-1010	FXD CER 1000PF +80-20% 6.3KV TYPE1		
C664	52-03-3469	FXD CER 0.01UF +100-0% 500V TYPE2		
C665	52-98-1010	FXD CER 1000PF +80-20% 6.3KV TYPE1		
C666	52-98-1010	FXD CER 1000PF +80-20% 6.3KV TYPE1		
C667	52-98-1000	FXD CER 4700PF +80-20% 3.15KV TYPE1		
C668	52-08-5145	FXD CER 22PF 10% 2KV TYPE1		
C669	50-67-0040	FXD PLSTC FILM 0.022UF 10% 100V		
C681	52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2		
C682	52-01-3345	FXD CER 1000PF 10% 500V TYPE2		
C685	52-03-3469	FXD CER 0.01UF +100-0% 500V TYPE2		
C686	54-00-0311	FXD ELECT 10UF 50V		
C687	52-03-3469	FXD CER 0.01UF +100-0% 500V TYPE2		
C688	52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2		
C689	52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2		
C811	54-00-0301	FXD ELECT 1UF 50V		
C812	55-37-2050	FXD TANT ELECT 1UF 35V		
C813	52-01-3345	FXD CER 1000PF 10% 500V TYPE2		
C814	55-37-2010	FXD TANT ELECT 0.22UF 35V		
C815	54-00-0121	FXD ELECT 100UF 25V		
C816	52-01-3345	FXD CER 1000PF 10% 500V TYPE2		
C817	55-37-2010	FXD TANT ELECT 0.22UF 35V		
C821	54-00-0311	FXD ELECT 10UF 50V		
C841	54-00-0311	FXD ELECT 10UF 50V		
C842	54-00-0311	FXD ELECT 10UF 50V		
C851	54-60-1730	FXD ELECT 47UF 200V		
C852	54-00-0032	FXD ELECT 2200UF 16V		
CR401	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR402	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR403	32-30-0860	DIODE VR 30V IO 30MA	HITACHI	1SS86
CR404	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR452	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR453	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR454	32-92-0033	ZENER VZ 3.2 - 3.4V	HITACHI	HZ3C-2

REFERENCE DESIGNATOR	KIKUSUI PARTS NO.	DESCRIPTION COS5020-ST		
CR455	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR456	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR457	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR458	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR459	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR460	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR461	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR462	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR463	32-30-0860	DIODE VR 30V IO 30MA	HITACHI	1SS86
CR464	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR465	32-92-0056	ZENER VZ 5.5 - 5.8V P 0.4W	NEC	RD5.6JB2
CR468	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR469	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR481	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR501	32-30-0860	DIODE VR 30V IO 30MA	HITACHI	1SS86
CR502	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR503	32-30-0830	DIODE VR 250V IO 200MA	HITACHI	1SS83
CR504	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR651	32-92-0056	ZENER VZ 5.5 - 5.8V P 0.4W	NEC	RD5.6JB2
CR652	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR653	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR654	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR655	32-90-1951	DIODE VR 6KV FAST RECOVERY	SANKEN	GHV-06SSN
CR656	32-90-1951	DIODE VR 6KV FAST RECOVERY	SANKEN	GHV-06SSN
CR657	32-90-2620	DIODE VR 200V FAST RECOVERY		
CR658	32-90-1820	DIODE VR 2KV FAST RECOVERY	HITACHI	ERB26-20
CR659	32-90-2620	DIODE VR 200V FAST RECOVERY		
CR660	32-90-2620	DIODE VR 200V FAST RECOVERY		
CR661	32-30-0830	DIODE VR 250V IO 200MA	HITACHI	1SS83
CR662	32-30-0830	DIODE VR 250V IO 200MA	HITACHI	1SS83
CR663	32-30-0830	DIODE VR 250V IO 200MA	HITACHI	1SS83
CR664	32-30-0830	DIODE VR 250V IO 200MA	HITACHI	1SS83
CR665	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR666	32-92-0022	ZENER VZ 2.1 - 2.3V	HITACHI	HZ2B-3
CR667	32-92-0022	ZENER VZ 2.1 - 2.3V	HITACHI	HZ2B-3
CR668	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR669	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR681	32-30-0860	DIODE VR 30V IO 30MA	HITACHI	1SS86
CR811	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR812	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR813	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR821	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR822	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR823	32-92-0360	ZENER VZ 35.3-36.8V	HITACHI	HZ36L-2
CR824	32-92-0056	ZENER VZ 5.5 - 5.8V P 0.4W	NEC	RD5.6JB2
CR825	32-92-0022	ZENER VZ 2.1 - 2.3V	HITACHI	HZ2B-3
CR851	32-90-2110	DIODE BRIGE VRM 400V IO 1A	TOSHIBA	1G4B42
CR852	32-90-2110	DIODE BRIGE VRM 400V IO 1A	TOSHIBA	1G4B42
CR853	32-92-0075	ZENER VZ 7.0 - 7.9V	NEC	RD7.5JB
DS651	23-70-0100	LAMP NEON		
DS652	23-70-0100	LAMP NEON		
L650	67-10-0890	INDUCTOR 100MH 10%		

REFERENCE DESIGNATOR	KIKUSUI PARTS NO.	DESCRIPTION COS5020-ST	
Q401	30-10-8381	TR SI PNP	MATSUSITA 2SA838-B
Q402	30-10-8381	TR SI PNP	MATSUSITA 2SA838-B
Q403	31-20-1073	FET IDSS 4.5-7.7MA	SONY 2SK107-3
Q404	30-31-9071	TR SI NPN	HITACHI 2SC1907
Q405	30-31-9071	TR SI NPN	HITACHI 2SC1907
Q406	30-10-8441	TR SI PNP	HITACHI 2SA844-D
Q407	30-10-8441	TR SI PNP	HITACHI 2SA844-D
Q408	30-10-8441	TR SI PNP	HITACHI 2SA844-D
Q409	30-10-8441	TR SI PNP	HITACHI 2SA844-D
Q410	31-20-1171	FET	TOSHIBA 2SK117-BL
Q411	30-11-0151	TR SI PNP	TOSHIBA 2SA1015-Y
Q412	30-10-8381	TR SI PNP	MATSUSITA 2SA838-B
Q413	30-31-9071	TR SI NPN	HITACHI 2SC1907
Q415	30-31-9071	TR SI NPN	HITACHI 2SC1907
Q416	30-10-8441	TR SI PNP	HITACHI 2SA844-D
Q417	30-31-9071	TR SI NPN	HITACHI 2SC1907
Q418	30-30-9451	TR SI NPN	NEC 2SC945-Q
Q419	30-10-8441	TR SI PNP	HITACHI 2SA844-D
Q420	30-10-8441	TR SI PNP	HITACHI 2SA844-D
Q421	30-30-9451	TR SI NPN	NEC 2SC945-Q
Q422	30-30-9451	TR SI NPN	NEC 2SC945-Q
Q423	30-10-8441	TR SI PNP	HITACHI 2SA844-D
Q424	30-31-8431	TR SI NPN	NEC 2SC1843-E
Q425	31-20-1171	FET	TOSHIBA 2SK117-BL
Q426	31-20-1171	FET	TOSHIBA 2SK117-BL
Q427	30-10-8441	TR SI PNP	HITACHI 2SA844-D
Q428	30-30-9451	TR SI NPN	NEC 2SC945-Q
Q429	30-10-8441	TR SI PNP	HITACHI 2SA844-D
Q430	30-10-8441	TR SI PNP	HITACHI 2SA844-D
Q431	30-30-9451	TR SI NPN	NEC 2SC945-Q
Q501	30-11-0151	TR SI PNP	TOSHIBA 2SA1015-Y
Q502	30-11-0151	TR SI PNP	TOSHIBA 2SA1015-Y
Q503	30-30-9451	TR SI NPN	NEC 2SC945-Q
Q504	30-30-9451	TR SI NPN	NEC 2SC945-Q
Q505	30-31-9071	TR SI NPN	HITACHI 2SC1907
Q506	30-31-9071	TR SI NPN	HITACHI 2SC1907
Q507	30-31-9071	TR SI NPN	HITACHI 2SC1907
Q508	30-10-8381	TR SI PNP	MATSUSITA 2SA838-B
Q509	30-20-6481	TR SI PNP	HITACHI 2SB648A
Q510	30-40-6681	TR SI NPN	HITACHI 2SD668A-C
Q511	30-40-6681	TR SI NPN	HITACHI 2SD668A-C
Q512	30-20-6481	TR SI PNP	HITACHI 2SB648A
Q651	30-40-8802	TR SI NPN	TOSHIBA 2SD880-Y
Q652	30-10-8441	TR SI PNP	HITACHI 2SA844-D
Q654	30-31-9071	TR SI NPN	HITACHI 2SC1907
Q655	30-31-9071	TR SI NPN	HITACHI 2SC1907
Q656	30-32-3710	TR SI NPN	NEC 2SC2371-L
Q657	30-32-3710	TR SI NPN	NEC 2SC2371-L
Q658	30-32-3710	TR SI NPN	NEC 2SC2371-L
Q659	30-32-3710	TR SI NPN	NEC 2SC2371-L
Q660	31-20-1171	FET	TOSHIBA 2SK117-BL
Q811	30-30-9451	TR SI NPN	NEC 2SC945-Q
Q812	30-30-9451	TR SI NPN	NEC 2SC945-Q

REFERENCE DESIGNATOR	KIKUSUI PARTS NO.	DESCRIPTION	COS5020-ST	
Q813	30-11-0151	TR SI PNP	TOSHIBA	2SA1015-Y
Q814	30-30-9451	TR SI NPN	NEC	2SC945-Q
Q815	30-30-9451	TR SI NPN	NEC	2SC945-Q
Q816	30-20-6481	TR SI PNP	HITACHI	2SB648A
Q818	30-32-3710	TR SI NPN	NEC	2SC2371-L
Q819	30-32-3710	TR SI NPN	NEC	2SC2371-L
Q851	30-31-5051	TR SI NPN	NEC	2SC1505-K
Q852	30-31-8431	TR SI NPN	NEC	2SC1843-E
Q853	30-40-8802	TR SI NPN	TOSHIBA	2SD880-Y
R401	40-27-0472	FXD C FILM 47 OHM 5% 1/4W		
R402	42-83-2100	FXD M FILM 1K OHM 1% 1/4W		
R403	40-27-2222	FXD C FILM 2.2K OHM 5% 1/4W		
R404	40-27-2122	FXD C FILM 1.2K OHM 5% 1/4W		
R405	40-27-2222	FXD C FILM 2.2K OHM 5% 1/4W		
R406	40-27-2332	FXD C FILM 3.3K OHM 5% 1/4W		
R407	40-27-0472	FXD C FILM 47 OHM 5% 1/4W		
R408	40-27-3472	FXD C FILM 47K OHM 5% 1/4W		
R409	42-33-0420	FXD M FILM 1M OHM 1% 1/2W		
R410	40-27-3102	FXD C FILM 10K OHM 5% 1/4W		
R411	40-27-2152	FXD C FILM 1.5K OHM 5% 1/4W		
R412	40-27-1562	FXD C FILM 560 OHM 5% 1/4W		
R413	40-27-1562	FXD C FILM 560 OHM 5% 1/4W		
R414	40-27-0682	FXD C FILM 68 OHM 5% 1/4W		
R415	40-27-2392	FXD C FILM 3.9K OHM 5% 1/4W		
R416	40-27-2392	FXD C FILM 3.9K OHM 5% 1/4W		
R417	40-27-1682	FXD C FILM 680 OHM 5% 1/4W		
R418	40-27-1682	FXD C FILM 680 OHM 5% 1/4W		
R419	40-27-1682	FXD C FILM 680 OHM 5% 1/4W		
R420	40-27-1682	FXD C FILM 680 OHM 5% 1/4W		
R421	40-27-4102	FXD C FILM 100K OHM 5% 1/4W		
R422	40-27-4102	FXD C FILM 100K OHM 5% 1/4W		
R423	40-27-2222	FXD C FILM 2.2K OHM 5% 1/4W		
R424	40-27-3222	FXD C FILM 22K OHM 5% 1/4W		
R425	40-27-3102	FXD C FILM 10K OHM 5% 1/4W		
R427	40-27-3102	FXD C FILM 10K OHM 5% 1/4W		
R428	40-27-0332	FXD C FILM 33 OHM 5% 1/4W		
R429	40-27-1562	FXD C FILM 560 OHM 5% 1/4W		
R431	40-27-3102	FXD C FILM 10K OHM 5% 1/4W		
R432	40-27-2102	FXD C FILM 1K OHM 5% 1/4W		
R433	40-27-4472	FXD C FILM 470K OHM 5% 1/4W		
R434	40-27-4472	FXD C FILM 470K OHM 5% 1/4W		
R435	40-27-1392	FXD C FILM 390 OHM 5% 1/4W		
R436	40-27-1102	FXD C FILM 100 OHM 5% 1/4W		
R437	40-27-1272	FXD C FILM 270 OHM 5% 1/4W		
R438	40-27-1102	FXD C FILM 100 OHM 5% 1/4W		
R440	40-27-2102	FXD C FILM 1K OHM 5% 1/4W		
R441	40-27-2222	FXD C FILM 2.2K OHM 5% 1/4W		
R442	40-27-8472	FXD C FILM 4.7 OHM 5% 1/4W		
R443	40-27-3472	FXD C FILM 47K OHM 5% 1/4W		
R452	40-27-1332	FXD C FILM 330 OHM 5% 1/4W		
R453	40-27-0222	FXD C FILM 22 OHM 5% 1/4W		
R454	40-27-3472	FXD C FILM 47K OHM 5% 1/4W		
R455	40-27-2182	FXD C FILM 1.8K OHM 5% 1/4W		

REFERENCE DESIGNATOR	KIKUSUI PARTS NO.	DESCRIPTION	COS5020-ST
R456	40-27-3102	FXD C FILM	10K OHM 5% 1/4W
R458	40-27-3102	FXD C FILM	10K OHM 5% 1/4W
R459	40-27-2562	FXD C FILM	5.6K OHM 5% 1/4W
R460	40-27-3472	FXD C FILM	47K OHM 5% 1/4W
R461	42-83-3220	FXD M FILM	22K OHM 1% 1/4W
R462	42-83-3330	FXD M FILM	33K OHM 1% 1/4W
R463	40-27-2272	FXD C FILM	2.7K OHM 5% 1/4W
R464	40-27-2472	FXD C FILM	4.7K OHM 5% 1/4W
R466	40-27-2102	FXD C FILM	1K OHM 5% 1/4W
R467	40-27-0472	FXD C FILM	47 OHM 5% 1/4W
R468	40-27-2222	FXD C FILM	2.2K OHM 5% 1/4W
R469	40-27-3102	FXD C FILM	10K OHM 5% 1/4W
R470	40-27-1822	FXD C FILM	820 OHM 5% 1/4W
R471	40-27-3562	FXD C FILM	56K OHM 5% 1/4W
R472	40-27-2222	FXD C FILM	2.2K OHM 5% 1/4W
R473	40-27-2122	FXD C FILM	1.2K OHM 5% 1/4W
R475	40-27-2392	FXD C FILM	3.9K OHM 5% 1/4W
R476	40-27-3182	FXD C FILM	18K OHM 5% 1/4W
R477	40-27-1222	FXD C FILM	220 OHM 5% 1/4W
R478	42-83-2220	FXD M FILM	2.2K OHM 1% 1/4W
R479	40-27-4472	FXD C FILM	470K OHM 5% 1/4W
R480	40-27-3102	FXD C FILM	10K OHM 5% 1/4W
R481	40-27-3332	FXD C FILM	33K OHM 5% 1/4W
R482	40-27-3102	FXD C FILM	10K OHM 5% 1/4W
R483	40-27-2472	FXD C FILM	4.7K OHM 5% 1/4W
R484	42-83-2160	FXD M FILM	1.6K OHM 1% 1/4W
R485	40-27-4102	FXD C FILM	100K OHM 5% 1/4W
R486	40-27-2332	FXD C FILM	3.3K OHM 5% 1/4W
R487	40-27-0102	FXD C FILM	10 OHM 5% 1/4W
R488	40-27-0102	FXD C FILM	10 OHM 5% 1/4W
R490	42-24-0231	FXD M GLAZE	5M OHM 1% 0.31W
R491	42-24-0231	FXD M GLAZE	5M OHM 1% 0.31W
R492	42-33-0420	FXD M FILM	1M OHM 1% 1/2W
R493	44-04-0010	FXD M GLAZE	R-NETWORK KIKUSUI S8109011
R494	42-83-2390	FXD M FILM	3.9K OHM 1% 1/4W
R495	42-83-1470	FXD M FILM	470 OHM 1% 1/4W
R496	40-27-3102	FXD C FILM	10K OHM 5% 1/4W
R498	40-27-1562	FXD C FILM	560 OHM 5% 1/4W
R499	40-27-1102	FXD C FILM	100 OHM 5% 1/4W
R501	40-27-2682	FXD C FILM	6.8K OHM 5% 1/4W
R502	40-27-1472	FXD C FILM	470 OHM 5% 1/4W
R503	42-83-0560	FXD M FILM	56 OHM 1% 1/4W
R504	40-27-2562	FXD C FILM	5.6K OHM 5% 1/4W
R505	40-27-2562	FXD C FILM	5.6K OHM 5% 1/4W
R506	40-27-2562	FXD C FILM	5.6K OHM 5% 1/4W
R507	40-27-2562	FXD C FILM	5.6K OHM 5% 1/4W
R508	42-83-2100	FXD M FILM	1K OHM 1% 1/4W
R509	42-83-2100	FXD M FILM	1K OHM 1% 1/4W
R510	42-83-2100	FXD M FILM	1K OHM 1% 1/4W
R511	42-83-1820	FXD M FILM	820 OHM 1% 1/4W
R512	40-27-1332	FXD C FILM	330 OHM 5% 1/4W
R513	40-27-1332	FXD C FILM	330 OHM 5% 1/4W
R514	40-27-3102	FXD C FILM	10K OHM 5% 1/4W
R515	40-27-4102	FXD C FILM	100K OHM 5% 1/4W

REFERENCE DESIGNATOR		KIKUSUI PARTS NO.	DESCRIPTION	COS5020-ST
R516		40-27-2222	FXD C FILM	2.2K OHM 5% 1/4W
R517		40-27-2222	FXD C FILM	2.2K OHM 5% 1/4W
R518		42-83-4100	FXD M FILM	100K OHM 1% 1/4W
R519		42-83-4100	FXD M FILM	100K OHM 1% 1/4W
R520		40-27-4102	FXD C FILM	100K OHM 5% 1/4W
R521		40-27-4102	FXD C FILM	100K OHM 5% 1/4W
R522		40-27-2152	FXD C FILM	1.5K OHM 5% 1/4W
R523		40-27-1682	FXD C FILM	680 OHM 5% 1/4W
R524		40-27-2152	FXD C FILM	1.5K OHM 5% 1/4W
R525		40-27-1682	FXD C FILM	680 OHM 5% 1/4W
R526		40-27-0472	FXD C FILM	47 OHM 5% 1/4W
R527		40-27-0472	FXD C FILM	47 OHM 5% 1/4W
R651		42-83-2820	FXD M FILM	8.2K OHM 1% 1/4W
R652		42-83-3120	FXD M FILM	12K OHM 1% 1/4W
R653	*	40-27-3332	FXD C FILM	33K OHM 5% 1/4W
R654		42-83-3390	FXD M FILM	39K OHM 1% 1/4W
R655		40-27-2102	FXD C FILM	1K OHM 5% 1/4W
R657		44-91-0010	FXD M OXIDE	1 OHM 5% 1W
R658		40-27-2152	FXD C FILM	1.5K OHM 5% 1/4W
R659		40-27-1472	FXD C FILM	470 OHM 5% 1/4W
R660		40-37-3221	FXD C FILM	22K OHM 5% 1/2W
R661		40-37-5331	FXD C FILM	3.3M OHM 5% 1/2W
R662		42-44-0330	FXD THICK FILM	10M OHM 1% 1W
R663		40-27-2102	FXD C FILM	1K OHM 5% 1/4W
R664		40-27-3472	FXD C FILM	47K OHM 5% 1/4W
R665		40-37-5221	FXD C FILM	2.2M OHM 5% 1/2W
R666		40-37-6101	FXD C FILM	10M OHM 5% 1/2W
R667		40-37-6101	FXD C FILM	10M OHM 5% 1/2W
R668		40-27-2332	FXD C FILM	3.3K OHM 5% 1/4W
R669		40-37-5151	FXD C FILM	1.5M OHM 5% 1/2W
R670		40-27-3822	FXD C FILM	82K OHM 5% 1/4W
R671		40-27-4102	FXD C FILM	100K OHM 5% 1/4W
R673		40-27-3102	FXD C FILM	10K OHM 5% 1/4W
R674		40-37-6101	FXD C FILM	10M OHM 5% 1/2W
R675		40-37-6101	FXD C FILM	10M OHM 5% 1/2W
R676		40-37-5101	FXD C FILM	1M OHM 5% 1/2W
R677		40-27-1102	FXD C FILM	100 OHM 5% 1/4W
R679		40-27-1102	FXD C FILM	100 OHM 5% 1/4W
R680		40-27-4472	FXD C FILM	470K OHM 5% 1/4W
R681		40-27-2822	FXD C FILM	8.2K OHM 5% 1/4W
R683		40-27-2332	FXD C FILM	3.3K OHM 5% 1/4W
R684		40-27-2222	FXD C FILM	2.2K OHM 5% 1/4W
R685		40-27-1102	FXD C FILM	100 OHM 5% 1/4W
R686		40-27-1222	FXD C FILM	220 OHM 5% 1/4W
R687		40-27-2562	FXD C FILM	5.6K OHM 5% 1/4W
R688		40-27-0822	FXD C FILM	82 OHM 5% 1/4W
R689		40-27-2472	FXD C FILM	4.7K OHM 5% 1/4W
R690		40-37-3471	FXD C FILM	47K OHM 5% 1/2W
R691		40-37-3471	FXD C FILM	47K OHM 5% 1/2W
R692		40-27-4102	FXD C FILM	100K OHM 5% 1/4W
R693		40-27-2102	FXD C FILM	1K OHM 5% 1/4W
R694		40-27-2102	FXD C FILM	1K OHM 5% 1/4W
R695		40-27-4102	FXD C FILM	100K OHM 5% 1/4W
R696		40-27-1102	FXD C FILM	100 OHM 5% 1/4W

REFERENCE DESIGNATOR		KIKUSUI PARTS NO.	DESCRIPTION	COS5020-ST	
R697		40-27-4102	FXD C FILM 100K OHM 5% 1/4W		
R698	*	40-27-3392	FXD C FILM 39K OHM 5% 1/4W		
R699		40-27-3562	FXD C FILM 56K OHM 5% 1/4W		
R810		40-27-2472	FXD C FILM 4.7K OHM 5% 1/4W		
R811		40-27-1472	FXD C FILM 470 OHM 5% 1/4W		
R812		40-27-3102	FXD C FILM 10K OHM 5% 1/4W		
R813		40-27-5102	FXD C FILM 1M OHM 5% 1/4W		
R814		40-27-3222	FXD C FILM 22K OHM 5% 1/4W		
R815		40-27-3472	FXD C FILM 47K OHM 5% 1/4W		
R816		40-27-4332	FXD C FILM 330K OHM 5% 1/4W		
R817		40-27-2392	FXD C FILM 3.9K OHM 5% 1/4W		
R818		40-27-2152	FXD C FILM 1.5K OHM 5% 1/4W		
R819		40-27-3222	FXD C FILM 22K OHM 5% 1/4W		
R820		40-27-4332	FXD C FILM 330K OHM 5% 1/4W		
R821		40-27-3102	FXD C FILM 10K OHM 5% 1/4W		
R822		40-27-2392	FXD C FILM 3.9K OHM 5% 1/4W		
R823		40-27-3102	FXD C FILM 10K OHM 5% 1/4W		
R824		40-27-2562	FXD C FILM 5.6K OHM 5% 1/4W		
R825		40-27-2472	FXD C FILM 4.7K OHM 5% 1/4W		
R826		40-27-3102	FXD C FILM 10K OHM 5% 1/4W		
R827		40-27-2392	FXD C FILM 3.9K OHM 5% 1/4W		
R828		40-27-2562	FXD C FILM 5.6K OHM 5% 1/4W		
R829		40-27-3472	FXD C FILM 47K OHM 5% 1/4W		
R830		40-27-4222	FXD C FILM 220K OHM 5% 1/4W		
R831		40-27-4222	FXD C FILM 220K OHM 5% 1/4W		
R832		40-27-2472	FXD C FILM 4.7K OHM 5% 1/4W		
R833		40-27-2102	FXD C FILM 1K OHM 5% 1/4W		
R834		40-27-1332	FXD C FILM 330 OHM 5% 1/4W		
R841		40-27-0102	FXD C FILM 10 OHM 5% 1/4W		
R842		40-27-0102	FXD C FILM 10 OHM 5% 1/4W		
R843		40-27-4222	FXD C FILM 220K OHM 5% 1/4W		
R844		40-27-4102	FXD C FILM 100K OHM 5% 1/4W		
R851		42-83-2390	FXD M FILM 3.9K OHM 1% 1/4W		
R852		42-34-2240	FXD M FILM 56K OHM 1% 1/2W		
R853		40-27-0472	FXD C FILM 47 OHM 5% 1/4W		
R1401		40-27-2102	FXD C FILM 1K OHM 5% 1/4W		
R1403		40-27-2102	FXD C FILM 1K OHM 5% 1/4W		
R1405		40-27-2102	FXD C FILM 1K OHM 5% 1/4W		
R1652		40-27-3182	FXD C FILM 18K OHM 5% 1/4W		
RV401		48-33-2500	VAR M FILM 5K OHM		
RV404		48-33-4500	VAR M FILM 500K OHM		
RV405		48-33-3100	VAR M FILM 10K OHM		
RV651		48-33-4500	VAR M FILM 500K OHM		
RV652		48-33-4100	VAR M FILM 100K OHM		
RV811		48-33-3100	VAR M FILM 10K OHM		
RV812		48-33-4500	VAR M FILM 500K OHM		
S401		82-70-5242	LEVER SWITCH	ALPS	SLR524-2
S402		82-70-5242	LEVER SWITCH	ALPS	SLR524-2
S403		82-70-5222	PUSH SWITCH	ALPS	SLR522-2
S406		80-98-0700	SWEEP-2 ROTARY	316561	
T651		63-92-0130	CONVERTOR TRANS	KIKUSUI	S810115

REFERENCE DESIGNATOR		KIKUSUI PARTS NO.	DESCRIPTION	COS5020-ST
U401		35-70-0001	QUAD 2-INPUT POSI-NAND	TEXAS INS.SN74LS00N
U402		35-70-1121	DUAL J-K F-F WITH P/C	TEXAS INS.SN74LS112N
U403		34-00-0215	J-FET INPUT OPE-AMP	TEXAS INS.TL081CP
U404		34-69-0030	TRIPLE 2-CHANNEL MULTIPLEXER	TOSHIBA TC4053BP
U651		34-00-0215	J-FET INPUT OPE-AMP	TEXAS INS.TL081CP
U801		35-69-0070	DUAL MONOSTABLE MULTI	TOSHIBA TC4528BP
U802		35-69-0070	DUAL MONOSTABLE MULTI	TOSHIBA TC4528BP
A4 ASSEMBLY				
C1605		50-45-0500	FXD PLSTC FILM 0.01MF 5% 50V	
C1606		50-45-0500	FXD PLSTC FILM 0.01MF 5% 50V	
C1607		52-06-2051	FXD CER 5P 10% 50V TYPE1	
C1608		52-01-3345	FXD CER 1000PF 10% 500V TYPE2	
C1609		54-00-0114	FXD ELECT 47UF 25V	
C1610		52-03-3469	FXD CER 0.01UF +100-0% 500V TYPE2	
CR1601		32-92-0360	ZENER VZ 35.3-36.8V	HITACHI HZ36L-2
CR1602		32-92-0360	ZENER VZ 35.3-36.8V	HITACHI HZ36L-2
CR1603		32-92-0360	ZENER VZ 35.3-36.8V	HITACHI HZ36L-2
CR1604		32-92-0360	ZENER VZ 35.3-36.8V	HITACHI HZ36L-2
CR1605		37-00-0061	LAMP LED GREEN	TOSHIBA TLG145
DS1601		23-44-0000	LAMP FILAMENT 14V 80MA	
DS1602		23-44-0000	LAMP FILAMENT 14V 80MA	
Q1601		30-31-8461	TR SI NPN	MATSUSITA 2SC1846-R
Q1602		30-31-8461	TR SI NPN	MATSUSITA 2SC1846-R
R1601	*	40-27-4102	FXD C FILM 100K OHM 5% 1/4W	
R1602		40-27-3102	FXD C FILM 10K OHM 5% 1/4W	
R1603		40-27-3102	FXD C FILM 10K OHM 5% 1/4W	
R1604		40-27-4102	FXD C FILM 100K OHM 5% 1/4W	
R1605		40-27-4102	FXD C FILM 100K OHM 5% 1/4W	
R1606		40-27-4222	FXD C FILM 220K OHM 5% 1/4W	
R1607		40-27-4472	FXD C FILM 470K OHM 5% 1/4W	
R1608		40-27-4472	FXD C FILM 470K OHM 5% 1/4W	
R1609		40-27-1472	FXD C FILM 470 OHM 5% 1/4W	
R1610		42-83-3100	FXD M FILM 10K OHM 1% 1/4W	
R1611	*	40-27-4102	FXD C FILM 100K OHM 5% 1/4W	
R1612		42-83-2200	FXD M FILM 2K OHM 1% 1/4W	
R1613		40-27-0102	FXD C FILM 10 OHM 5% 1/4W	
R1614		40-27-1682	FXD C FILM 680 OHM 5% 1/4W	
R1615		40-27-8472	FXD C FILM 4.7 OHM 5% 1/4W	
R1616		40-27-1562	FXD C FILM 560 OHM 5% 1/4W	
RV1601		45-44-3100	VAR C COMP 10K OHM	
RV1603		45-44-4200	VAR C COMP 200K OHM	
RV1604		45-43-2200	VAR M GLAZE 2K OHM	
RV1605		45-44-3100	VAR C COMP 10K OHM	
U1601		35-60-0000	QUAD 2-INPUT NAND GATES	TOSHIBA TC4011BP

REFERENCE DESIGNATOR	KIKUSUI PARTS NO.	DESCRIPTION	COS5020-ST	
B	ASSEMBLY			
C453	52-01-3345	FXD CER 1000PF 10% 500V TYPE2		
C466	52-05-1498	FXD CER 0.1UF +80-20% 25V TYPE2		
C601	52-77-1010	FXD CER 1000PF 250VAC FOR UL & CSA		
C602	52-77-1010	FXD CER 1000PF 250VAC FOR UL & CSA		
C801	52-01-3345	FXD CER 1000PF 10% 500V TYPE2		
C802	52-01-3345	FXD CER 1000PF 10% 500V TYPE2		
C861	54-00-0301	FXD ELECT 1UF 50V		
CR409	37-00-0082	LAMP LED RED	TOSHIBA	TLR102KW
CR451	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR801	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR802	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR861	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
Q817	30-32-3710	TR SI NPN	NEC	2SC2371-L
Q861	30-31-8151	TR SI NPN	TOSHIBA	2SC1815-Y
R101	40-27-0472	FXD C FILM 47 OHM 5% 1/4W		
R201	40-27-0472	FXD C FILM 47 OHM 5% 1/4W		
R426	40-27-2822	FXD C FILM 8.2K OHM 5% 1/4W		
R457	40-27-3102	FXD C FILM 10K OHM 5% 1/4W		
R801	40-27-3102	FXD C FILM 10K OHM 5% 1/4W		
R802	44-07-0040	FXD M GLAZE R-NETWORK		
R803	40-27-4102	FXD C FILM 100K OHM 5% 1/4W		
R804	40-27-2102	FXD C FILM 1K OHM 5% 1/4W		
R805	40-27-3332	FXD C FILM 33K OHM 5% 1/4W		
R806	42-82-3191	FXD M FILM 19K OHM 0.5% 1/4W		
R807	40-27-4102	FXD C FILM 100K OHM 5% 1/4W		
R808	42-83-2100	FXD M FILM 1K OHM 1% 1/4W		
R861	40-27-3102	FXD C FILM 10K OHM 5% 1/4W		
R862	40-27-5102	FXD C FILM 1M OHM 5% 1/4W		
R1402	40-27-0562	FXD C FILM 56 OHM 5% 1/4W		
RV111	45-01-0700	VAR C COMP 10K OHM WITH SW		
RV211	45-01-0700	VAR C COMP 10K OHM WITH SW		
RV402	45-01-0550	VAR C COMP 10K/100K OHM B		
RV501	45-35-3103	VAR C COMP 10K OHM		
RV801	45-01-0740	VAR C COMP 10K/1M OHM B		
S404	81-03-0270	PUSH SWITCH	ALPS	SUE30
S801	81-04-0300	PUSH SWITCH	ALPS	SUE40
S1601	81-01-0270	PUSH SWITCH	ALPS	SDG5P-E
T601	60-46-0080	POWER TRANS FOR COS5020-ST	KIKUSUI	S820667
TM1	97-04-0010	TIMER TM-3		
U861	35-60-0000	QUAD 2-INPUT NAND GATES	TOSHIBA	TC4011BP
V601	21-15-0602	CATHODE RAY TUBE	TOSHIBA	E2668B1

4.4.7 Mechanical Assembly Drawing and Parts (Mechanical)

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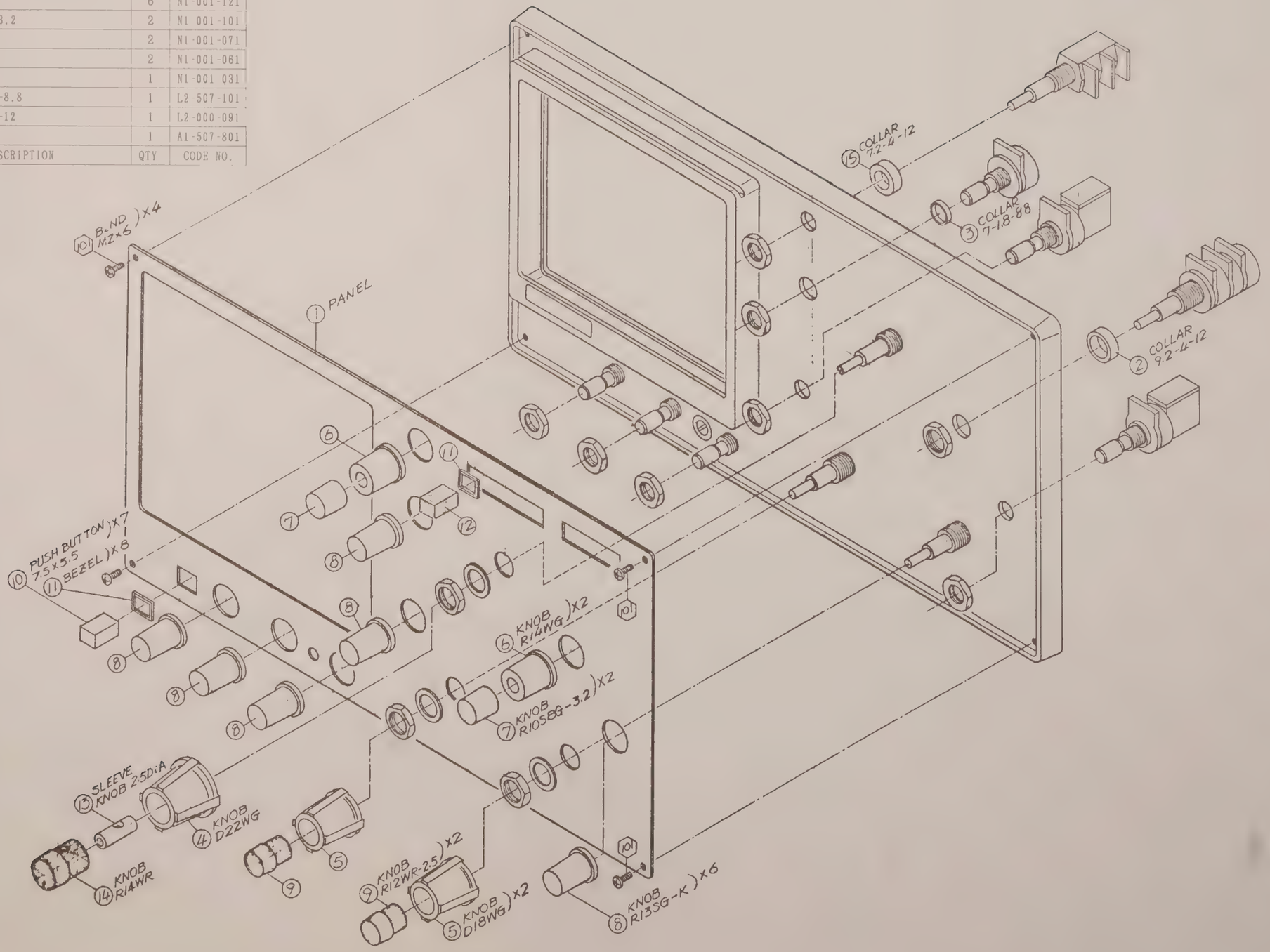
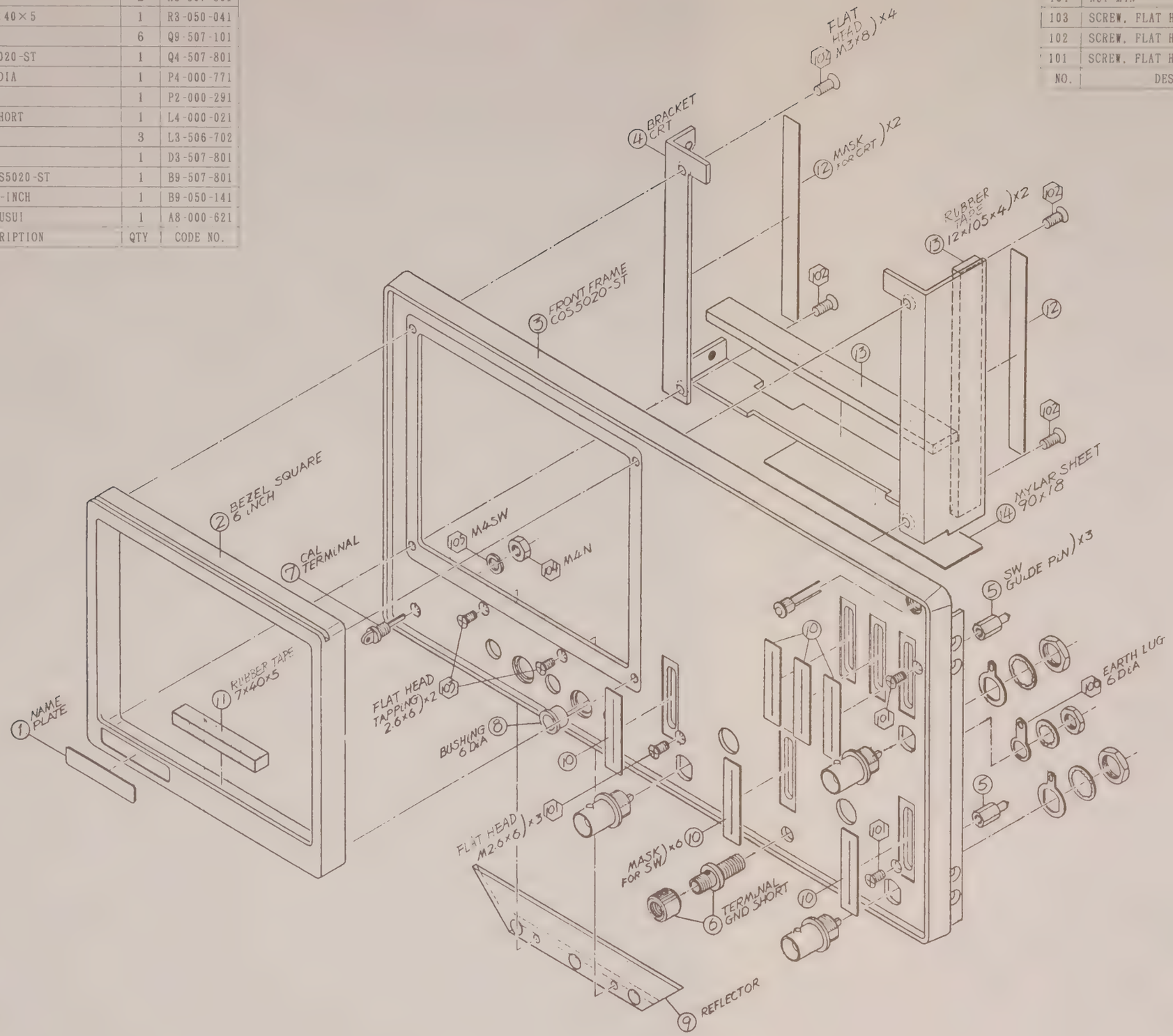
NO.	DESCRIPTION	QTY	CODE NO.
15	COLLAR 7.2-4-12	1	L2-507 801
14	KNOB R14WR	1	N2-000 061
13	SLEEVE KNOB 2.5DIA	1	K8-507 201
12	PUSH BUTTON 7.5×5.5 BR	1	P2-000-371
11	BEZEL FOR PUSH BUTTON	8	P2 000-331
10	PUSH BUTTON 7.5×5.5	7	P2-000 321
9	KNOB R12WR-2.5	2	N2 000 051
8	KNOB R13SG K	6	N1-001-121
7	KNOB R10SBG-3.2	2	N1 001-101
6	KNOB R14WG	2	N1-001-071
5	KNOB D18WG	2	N1-001-061
4	KNOB D22WG	1	N1-001 031
3	COLLAR 7-1.8-8.8	1	L2-507-101
2	COLLAR 9.2-4-12	1	L2-000-091
1	PANEL FRONT	1	A1-507-801

NO.	DESCRIPTION	QTY	CODE NO
101	SCREW. BINDER HEAD M2×6 S N1	4	M2 000 601



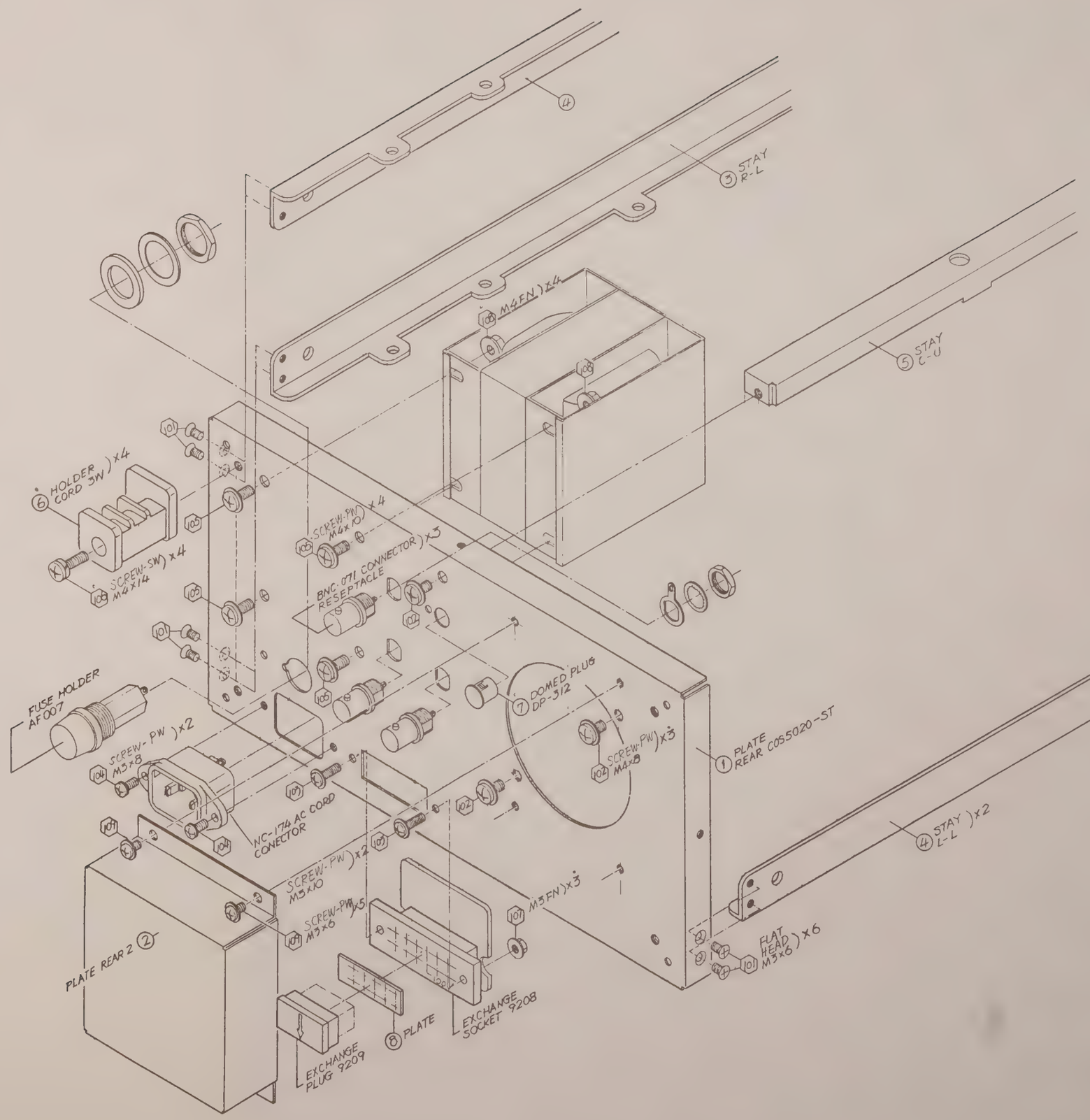
NO.	DESCRIPTION	QTY	CODE NO.
14	MYLAR SHEET 90×18	1	Q1-507-801
13	RUBBER TAPE 12×105×4	2	R3-507-802
12	MASK FOR CRT	2	R3-507-801
11	RUBBER TAPE 7×40×5	1	R3-050-041
10	MASK FOR SW	6	Q9-507-101
9	REFLECTOR COS5020-ST	1	Q4-507-801
8	SNAP BUSHING 6DIA	1	P4-000-771
7	CAL TERMINAL	1	P2-000-291
6	TERMINAL GND SHORT	1	L4-000-021
5	SW GUIDE P4N	3	L3-506-702
4	BRACKET CRT	1	D3-507-801
3	FRONT FRAME COS5020-ST	1	B9-507-801
2	BEZEL SQUARE 6-INCH	1	B9-050-141
1	NAME PLATE KIKUSUI	1	A8-000-621

NO.	DESCRIPTION	QTY	CODE NO.
106	EARTH LUG 6DIA	1	M6-000-151
105	WASHER M4SW	1	M5-011-041
104	NUT M4N	1	M4-011-041
103	SCREW, FLAT HEAD TAPPING 2.6×6	2	M2-001-401
102	SCREW, FLAT HEAD M3×8	4	M2-001-091
101	SCREW, FLAT HEAD M2.6×6	3	M2-001-041

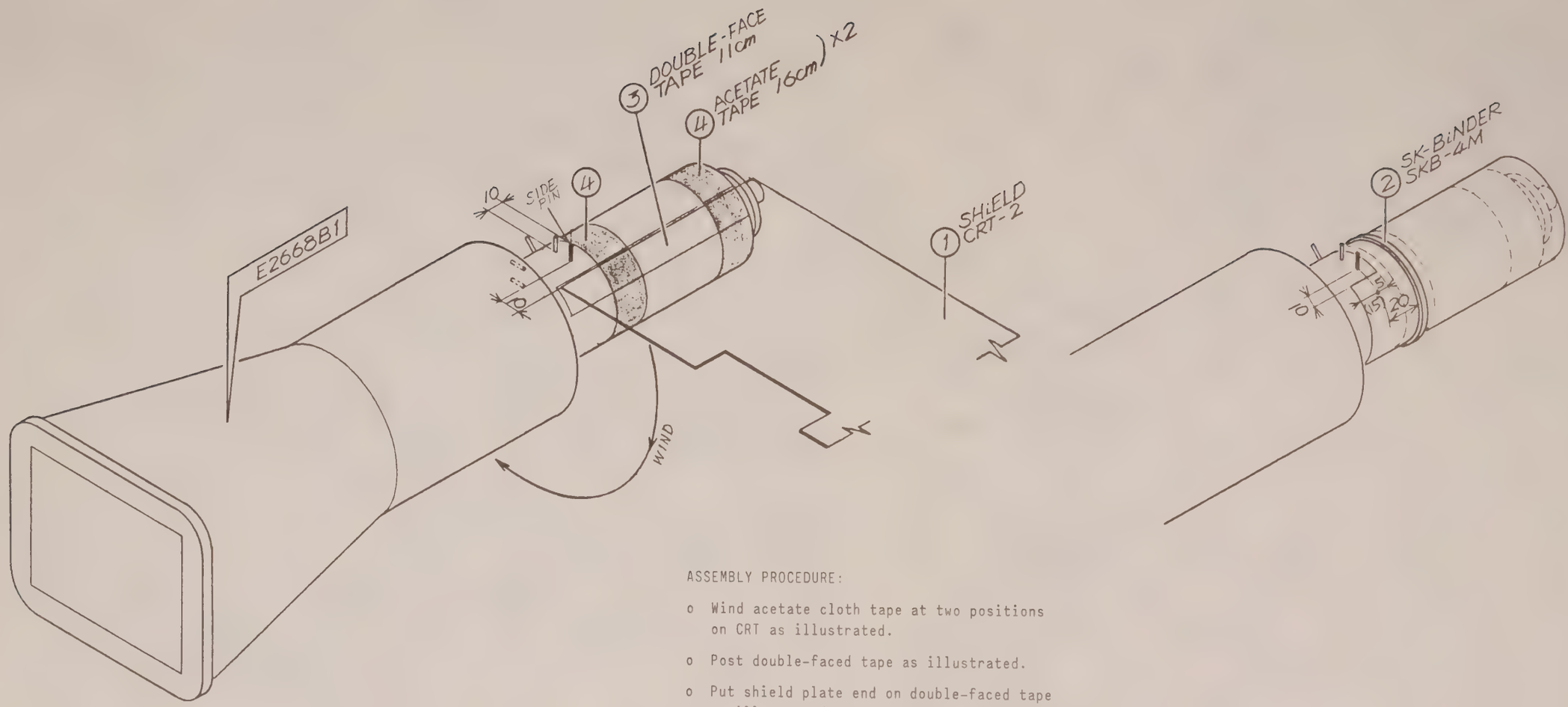


NO.	DESCRIPTION	QTY	CODE NO.
8	PLATE VOLTAGE SELECTOR	1	Q2-000-191
7	DOMED PLUG DP-312	1	P4-050-081
6	HOLDER CODE 3W	4	P3-000-101
5	STAY C-U	1	D5-507-803
4	STAY L-L	2	D5-507-802
3	STAY R-L	1	D5-507-801
2	PLATE REAR 2	1	B6-507-802
1	PLATE REAR	1	B6 507-801

NO.	DESCRIPTION	QTY	CODE NO.
109	SCREW WITH PW M3×6	5	M3-000-011
108	FLANGE NUT M4FN	4	M4-010-031
107	FLANGE NUT M3FN	3	M4-010-021
106	SCREW WITH SW M4×14	4	M3-011-101
105	SCREW WITH PW M4×10	4	M3-000-061
104	SCREW WITH PW M3×8	2	M3-000-041
103	SCREW WITH PW M3×10	2	M3-000-031
102	SCREW WITH PW M4×8	3	M3-000-021
101	SCREW, FLAT HEAD M3×6	6	M2-001-081



NO.	DESCRIPTION	QTY	CODE NO.
4	ADHESIVE TAPE "ACETATE" 571S	32cm	T4-000-131
3	ADHESIVE TAPE NO.721B	11cm	T4-000-091
2	SK-BINDER SKB-4M	1	P4-000-575
1	SHIELD CRT-2 340×125	1	C8-507-802

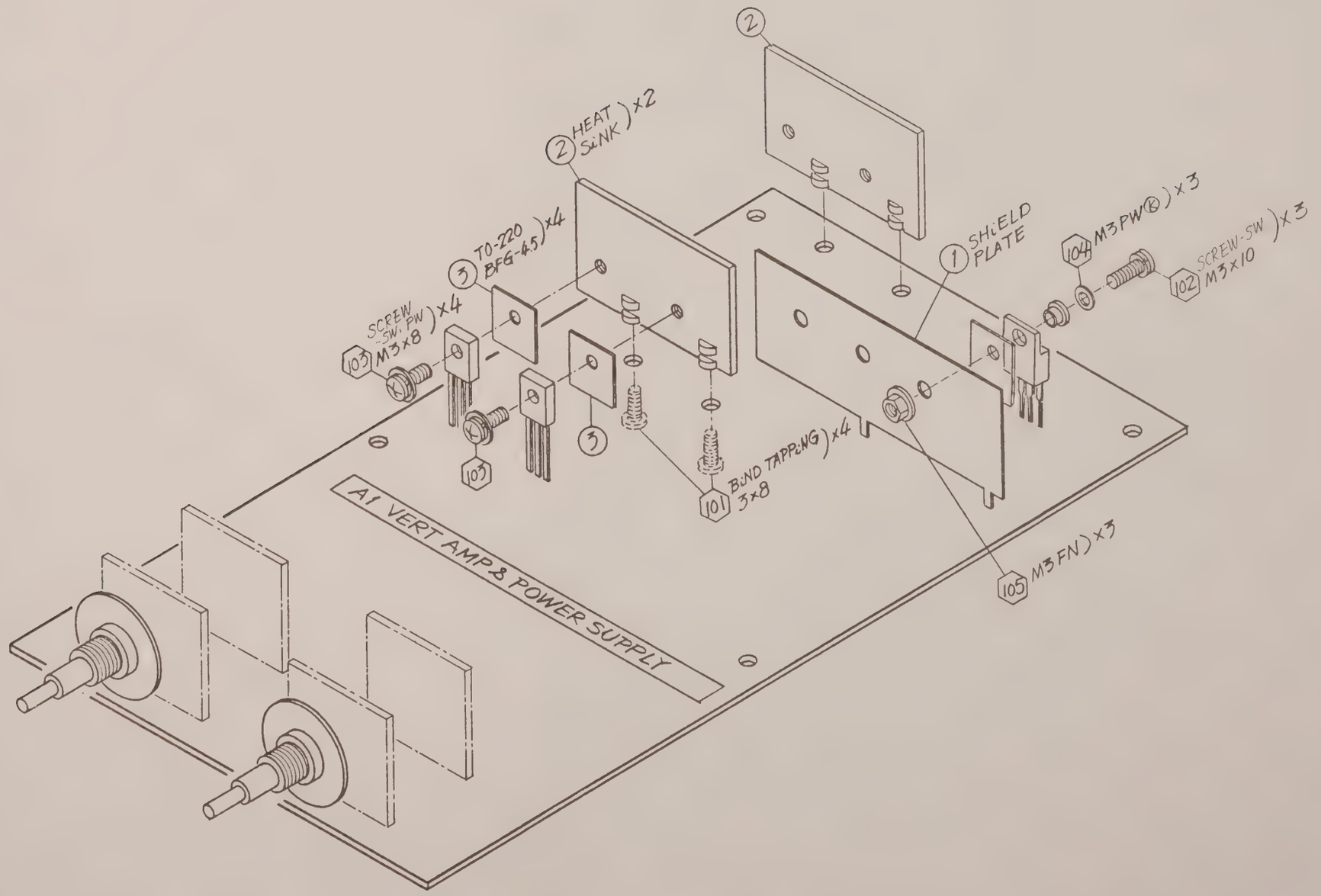


ASSEMBLY PROCEDURE:

- o Wind acetate cloth tape at two positions on CRT as illustrated.
- o Post double-faced tape as illustrated.
- o Put shield plate end on double-faced tape as illustrated, and wind shield board on CRT, exercising case so that no gaps are formed.
- o Clamp shield plate with SK binder as illustrated.

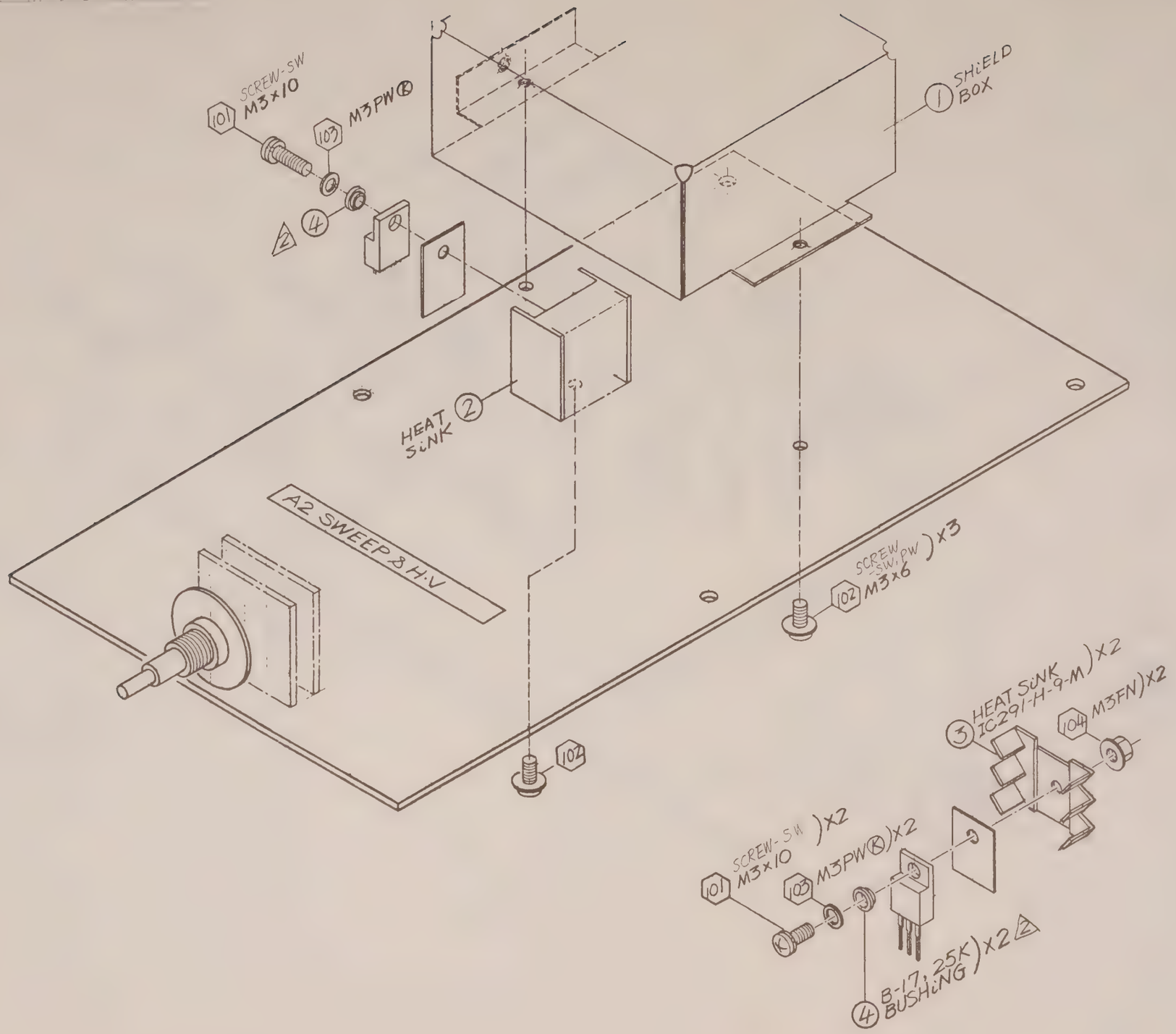
NO.	DESCRIPTION	QTY	CODE NO.
3	TO-220 D-4 BFG-45	4	X1-000-241
2	HEAT SINK	2	H1-505-801
1	SHIELD PLATE 30×80×0.3	1	C9-050-131

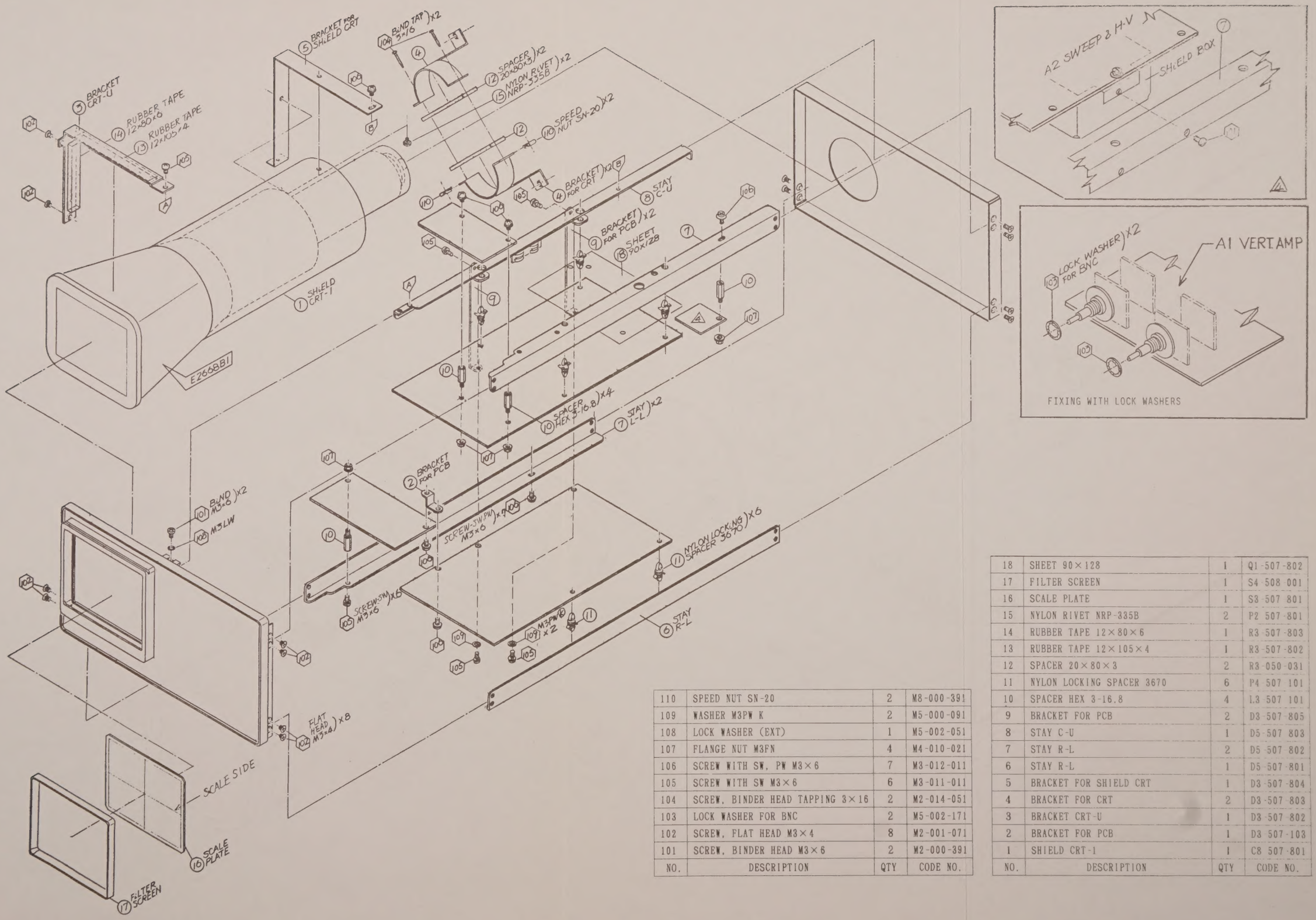
NO.	DESCRIPTION	QTY	CODE NO.
105	FLANGE NUT M3FN	3	M4-010-021
104	WASHER M3PW K	3	M4-000-081
103	SCREW WITH SW. PW M3×8	4	M3 012-021
102	SCREW WITH SW M3×10	3	M3-011-031
101	SCREW, BINDER HEAD TAPPING 3×8	4	M2 014-021



NO.	DESCRIPTION	QTY	CODE NO.
4	BUSHING B-17, 25K	3	Q2-000-231
3	HEAT SINK IC-291-H-9-M	2	H2-000-201
2	HEAT SINK IC-2425-ST	1	H2-000-181
1	SHIELD BOX FOR DD-CON	1	C8-505-601

NO.	DESCRIPTION	QTY	CODE NO.
104	FLANGE NUT M3FN	2	M4-010-021
103	WASHER M3PW K	3	M4-000-081
102	SCREW WITH SW. PW M3×6	3	M3-012-011
101	SCREW WITH SW M3×10	3	M3-011-031



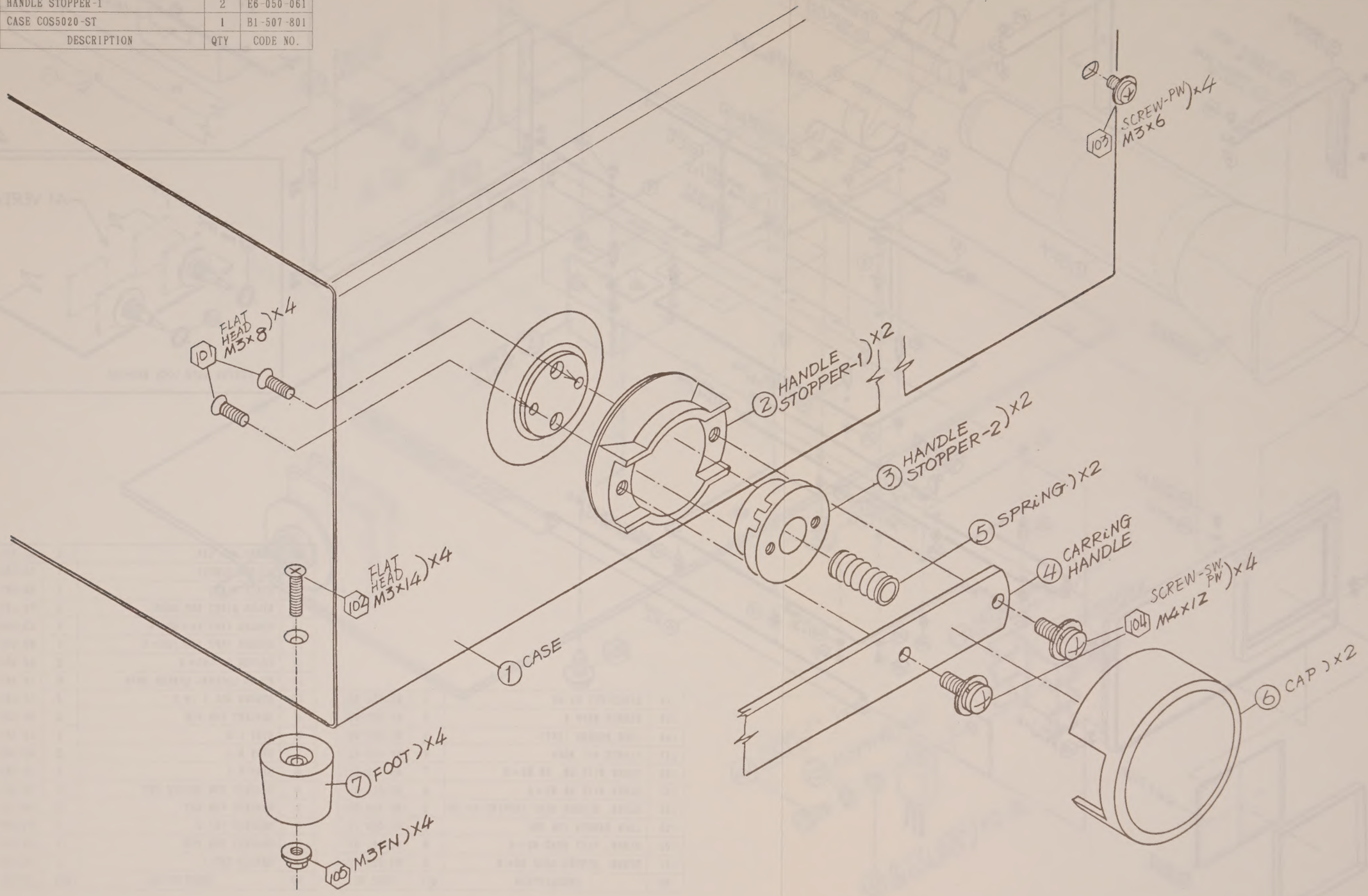


110	SPEED NUT SN-20	2	M8-000-391
109	WASHER M3PW K	2	M5-000-091
108	LOCK WASHER (EXT)	1	M5-002-051
107	FLANGE NUT M3FN	4	M4-010-021
106	SCREW WITH SW, PW M3×6	7	M3-012-011
105	SCREW WITH SW M3×6	6	M3-011-011
104	SCREW, BINDER HEAD TAPPING 3×16	2	M2-014-051
103	LOCK WASHER FOR BNC	2	M5-002-171
102	SCREW, FLAT HEAD M3×4	8	M2-001-071
101	SCREW, BINDER HEAD M3×6	2	M2-000-391
NO.	DESCRIPTION	QTY	CODE NO.

18	SHEET 90×128	1	Q1-507-802
17	FILTER SCREEN	1	S4 508 001
16	SCALE PLATE	1	S3-507-801
15	NYLON RIVET NRP-335B	2	P2 507-801
14	RUBBER TAPE 12×80×6	1	R3-507-803
13	RUBBER TAPE 12×105×4	1	R3-507-802
12	SPACER 20×80×3	2	R3-050-031
11	NYLON LOCKING SPACER 3670	6	P4 507 101
10	SPACER HEX 3-16.8	4	L3 507 101
9	BRACKET FOR PCB	2	D3-507-805
8	STAY C-U	1	D5-507-803
7	STAY R-L	2	D5-507-802
6	STAY R-L	1	D5-507-801
5	BRACKET FOR SHIELD CRT	1	D3-507-804
4	BRACKET FOR CRT	2	D3-507-803
3	BRACKET CRT-U	1	D3-507-802
2	BRACKET FOR PCB	1	D3 507-103
1	SHIELD CRT-1	1	C8 507-801
NO.	DESCRIPTION	QTY	CODE NO.

8	NAME PLATE KIKUSUI	1	A8-000-581
7	FOOT 20-17	4	P2-000-381
6	CAP HANDLE STOPPER	2	P1-050-011
5	SPRING HANDLE STOPPER	2	L5-050-011
4	CARRYING HANDLE	1	E6-507-101
3	HANDLE STOPPER-2	2	E6-050-071
2	HANDLE STOPPER-1	2	E6-050-061
1	CASE COS5020-ST	1	B1-507-801
NO.	DESCRIPTION	QTY	CODE NO.

105	FLANGE NUT M3FN	4	M4-010-021
104	SCREW WITH SW, PW M4×12	4	M3-012-011
103	SCREW WITH PW M3×6 B-NI	4	M3-000-011
102	SCREW, FLAT HEAD M3×14	4	M2-001-391
101	SCREW, FLAT HEAD M3×8	4	M2-011-091
NO.	DESCRIPTION	QTY	CODE NO.



COVER & HANDLE ASSEMBLY

316751

LIMITED WARRANTY

All instruments sold by KIKUSUI INTERNATIONAL CORPORATION are warranted to the original purchaser against defects in materials and workmanship from the date of original shipment to the purchaser within the following time limits:

Oscilloscope	—	2 year limited warranty
Power Supply	—	5 year limited warranty
Test Instrument	—	1 year limited warranty

However, this warranty excludes accessories, batteries, lead wires, and probes. Also, this warranty does not apply to any instruments determined by KIKUSUI INTERNATIONAL CORPORATION to have been subjected to customer alteration, modification, negligence or misuse.

In the event of any defects determined by KIKUSUI INTERNATIONAL CORPORATION to be covered by this warranty, KIKUSUI INTERNATIONAL CORPORATION will, at its sole option, repair or replace the defective instrument without charge and at its expense reship anywhere in the United States. To obtain warranty service, the defective instrument must be returned within thirty (30) days after the expiration of the applicable warranty period to KIKUSUI INTERNATIONAL CORPORATION or an Authorized Warranty Repair Station, properly packaged and with transportation and insurance prepaid. This warranty is valid only in the United States of America. Any customers of KIKUSUI INTERNATIONAL CORPORATION located outside of the United States should check with their nearest Authorized Agent for warranty information applicable to them.

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17819 S. Figueroa St., Gardena, Ca. 90248 · (213) 515-6432 · TWX910-346-7648 KIKUSUI GDNA

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